SCIENCE

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PRACTICAL CLASSIFICATION OF SOILS

Relation of the Soil to Agricultural Practise.—The comprehensive study of agricultural questions which has arisen in recent years has revealed the necessity for accurate information on the character and distribution of soil conditions. It is being more clearly recognized how fundamentally the soil enters into all questions of agricultural betterment, both scientific and practical. Not only does the intelligent management of the soil rest upon a proper appreciation of the inherent physical, chemical and biological variations in soils in different parts of the country, but the suitability of these to different crops, the adustment of the crops which can best be produced to the business organization of the farm, its size, equipment, money product, transportation and market facilities, and the social life of the community are involved. The application of the results of the investigation of the institutions for agricultural research—the experiment stations, the colleges of agriculture and the federal and state departments of agriculture—must take account first of all of soil conditions. Types and varieties of crops, methods of culture, tillage, drainage, irrigation and fertilization give better results upon some types of soil than upon others. Those which are well suited to one soil may be a total failure upon some other soil. The experiment stations have often confined their study to one or two types of soil on the central institution farm. It is only within very recent years that the importance of carrying on investigations at substations, upon the several typical soil

formations which may exist in their territory, has been recognized. In all these and many other even larger questions a knowledge of the variety and distribution of the soils of a territory is of prime importance.

Principles of Classification.—The study of any group of facts or phenomena involves an understanding of the properties in which they may differ, and the systematic representation of these differences requires that the properties of importance be arranged and classified with reference to some controlling interest. Soil is no exception to this general rule, but the application of these principles in the field description of soils in a practical way and from the agricultural point of view presents many and complicated problems.

Definition of Soil.—In the discussion of the classification of soils, the soil should be viewed very broadly so as to include any portion of the earth's surface capable of producing plants. It includes thin, stony material as well as that of great depth and friability. It includes desert regions as well as humid regions. It includes the material as deep as any influence is exerted upon plants growing on the surface.

Requisites of Scheme of Soil Classification.—The classification of soil to be of the largest value should effect the accurate separation of materials with reference to all important inherent agricultural differences. This statement indicates the breadth of the point of view to be taken. It is that of the farmer—agriculture in its broadest sense. The classification should not be confined to any particular section of plant production. It should apply to flowers and forests as well as wheat and cotton. It should have a place for the roughest mountain region as well as for the most intensively tilled garden. To be less comprehensive is to invite arbitrary judgment and corresponding inaccuracy in the application of the scheme in the field. The distinctions with reference to plant growth and agricultural practise which should be made are differences in, first, chemical composition, including total content of plant food, amount of lime, amount and condition of the organic matter and the solubility of all these, including the presence of alkali salts; second, physical properties including texture, structure, color, moisture capacity, aeration and temperature; third, the climate under which these properties exist. These distinctions which will determine natural plant growth will also make sufficient provision for agricultural practise necessary to produce domestic crops.

The ideal result of the scheme of soil classificaton is to separate all soil material into types or individuals which are uniform in their agricultural value and distinct from every other type of soil. The soil type must be the unit and the primarily important separation in the scheme. Once the types are recognized they may be grouped according to any selected properties, irrespective of those involved in arriving at their identity.

Difficulties in the Field Separation of Soils.—Having pointed out the properties with reference to which soils should be classified, the next problem is to apply these in a systematic way in the field. Herein arise two kinds of difficulties: First, to classify soils directly by their properties for plant growth is impracticable. Take chemical composition, for example. To classify soils upon the basis of chemical analysis of samples of every acre or even every ten acres is impracticable because of the large amount of labor and time involved. To directly determine the moisture capacity, temperature and other essential factors of plant growth presents similar practical difficulties. The direct

method must, therefore, be set aside. The important crop-producing properties must be correlated with some group of characteristics of the soil which are more easily recognized and grouped, and by this means arrive at individual types of soil which have some measure of agricultural unity and value. The more perfect this correlation of properties the more satisfactory will be the result. The characteristics of the soil which have been most often selected for correlation with its crop-producing properties are the geological. Second. Herein lies the second group of difficulties, namely, in establishing the correct relation between crop-producing power and geological origin, and also in the accurate separation of soil material along geological lines, due to the complexity of the geological processes and materials involved. Attention should be directed here to a point often overlooked, namely, that the separation of soils along geological lines is secondary to their separation according to crop-producing power. The method is an incident to the result, however interesting it may be as a part of the science of geology. Much confusion in work has resulted from the failure to sense this distinction. The soil type is a geological element in the structure of the earth and as such is legitimately investigated by the geologist. Unfortunately, for agricultural purposes, the geologist has seldom carried his separations far enough, due probably to the fact that he has not had the agricultural point of view and, therefore, has not appreciated the kind of distinctions which are demanded for farming purposes. This may be termed the agronomic point of view.

Principles which have been used in the Classification of Soils.—The soil has been classified from many points of view. Emmons[1] studied the soils of New York between 1835 and 1840 and made somewhat extensive chemical analyses of the soils in the several regions into which the state was divided. This is probably the most extensive of the early surveys and combined the chemical composition with geological origin in arriving at the agricultural separation, a method generally employed by investigators working in this field. The physical properties of the material were also recognized as important, but these several factors were not correlated in any definite way. Owen and Peters[2] made a very comprehensive study of the chemical composition of the soils of Kentucky. Hilgard[3] has made the largest collection of the chemical analyses of soils available in America, in connection with the investigation of the cotton soils, and the soils are classified in the field and indicated on maps with reference to the native vegetation. The mode of formation and physical properties received consideration. Shaler[4] in an article published in 1891 called attention rather definitely to the relation between the processes of soil formation and the character of the material and pointed out correlated types of plant growth.

In foreign countries a number of men have studied the problem of the practical classification of soils and of these the Russians have been most successful. Dokou-

[1] Emmons, Ebenezer, "The Soils of New York. Natural History of New York," Agriculture, I., 207–360 (1843), 1846.

[2] Owen, D. D., Geological Survey, Kentucky, Annual Repts., 1855–1875. Peters, Robert, "Chemical Composition of Soils, Marls, Ores, etc., Chemical Analysis A," Pts. I., II., III., 1875–1888.

[3] Hilgard, E. W., "Cotton Production," 10th Census, V. and VI., 1880.

[4] Shaler, N. S., "Origin and Nature of Soils," 12th Ann. Rept. U. S. G. S., Pt. I., 219–345, 1890–91.

chayev with his pupils,[5] the most prominent of whom is Subertzev,[6] studied these questions for many years and arrived at what may be termed the most perfect and comprehensive scheme devised up to the present time. Theirs is a genetic system based upon climate, the formation of the soil, and the apparent properties. It was rather a statement of broad groups than the designation in systematic order of the factors, which give rise to agricultural differences in soils.

The credit for definitely correlating the physical properties of the soil with its agricultural belongs chiefly to Whitney[7] and his associates. By his work the textural properties of the soil, through their influence on the moisture capacity and general climate of the soil, were shown to have a very determinate effect on the crop-producing power of the soil. The adaptation of natural vegetation and of domestic plants largely reflects these properties. Grass is shown to be generally identified with fine-textured soils, corn with loams and truck and other special crops with rather light sandy loams.

The Federal Soil Survey.—In 1899, as chief of the United States Division of Soils, Whitney began the classification and mapping of soils in the field according to their evident agricultural value. At first the physical properties were used almost exclusively as the means of separation. This survey work expanded and many men were employed in the field. Gradually the scheme of classification expanded, under the lash of necessity, keeping always to the fore the agricultural significance of each separation. Over four hundred thousand square miles were surveyed up to the beginning of 1911, distributed more or less in every state in the union. These surveys have proved their value and more than anything else have demonstrated the necessity of such work as a basis in general agricultural investigations and in education. They have also exemplified the necessity of arriving at definite principles for the classification of soils which in their distribution have little relation to political boundaries. Following the lead of the federal government and as a supplement thereto, many of the states have taken up survey work, some independently and some in cooperation with the federal bureau. All this emphasizes the need for a common basis for work such as the committee on soil classification of the American Society of Agronomy is endeavoring to establish.

While of great value and proceeding upon a broad basis of separation of soil types designed to represent their chief agricultural differences, on the one hand, the work has not always been as accurate as it might have been and, on the other hand, it has not been properly understood or appreciated because the factors which are used in the classification of soils have never been accurately stated. Individual survey men have been left very largely to absorb the scheme of separation from contact with the older men in the bureau and to work it out for themselves from previous training and especially from experience in the field. Apparently the factors which are used in the separation of soils are not always recognized and the grouping of types is often not upon parallel lines or lines of equal significance. The properties which determine differences in value have not been clearly perceived. The corollary of inaccurate grouping is inaccurate boundaries of soil types. As an in-

[5] Tulaikov, N., "The Genetic Classification of Soils," *Jr. Agr. Sci.*, 3, No. 1, pp. 80-85, 1908.

[6] Subertzev, N., *Expt. Sta. Record*, 12, 704-712, 1900; 12, 807-818, 1901.

[7] Whitney, M., U. S. Weather Bureau Bul. 4. Also Buls. S. C. Agr. Expt. Sta., Md. Agr. Exp. Sta. and U. S. Bureau of Soils.

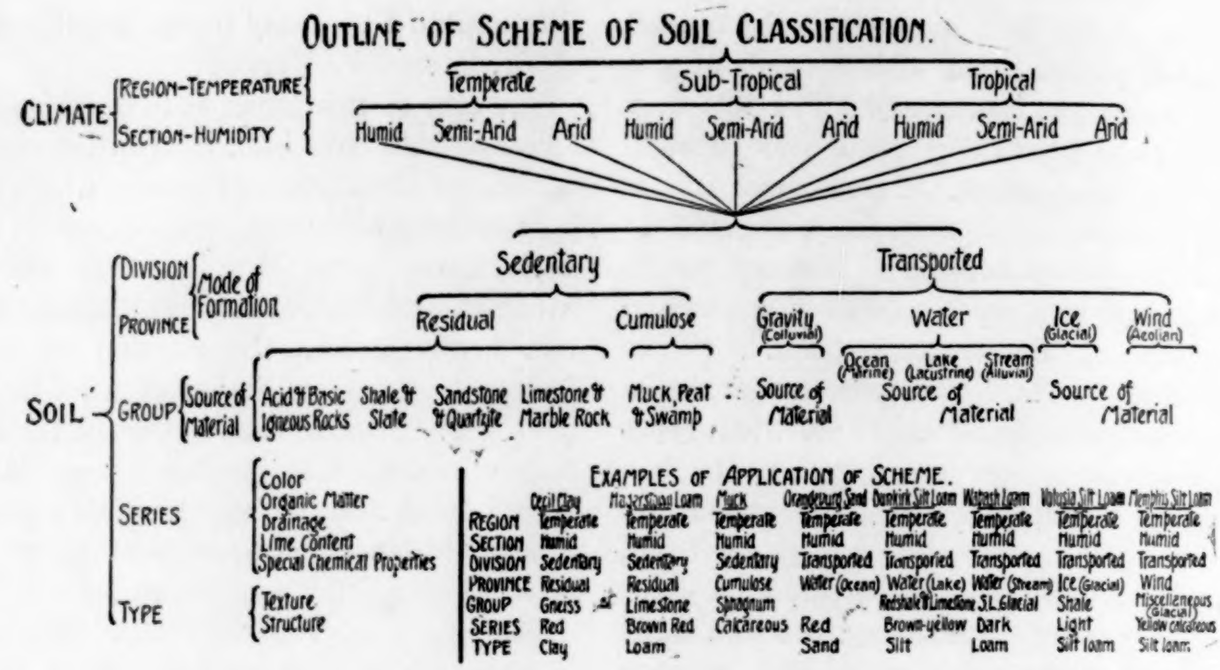
stance of the first inaccuracy the coastal plain is put on a par with the soils of glacial formation, however justified this may seem to be from the point of view of agricultural prominence. In the same line is the correlation of material occurring in the Ohio River bottom in Mason County, Kentucky, with the Norfolk series which is a part of the coastal plain. (Since changed.) The most serious errors in drawing the boundaries of individual types result from failure to appreciate the factors upon which the larger separations are made. These difficulties are pointed out, not to minimize the value of the work done, for they weigh lightly against the large and fundamental value of the surveys which have been completed, and which in the main are sound, but rather with the purpose to illustrate the importance of stating as clearly as possible the factors which are used in the practical classification of soils and the comparison of these with what may be termed an ideal scheme of classification. It is objected by some persons that it is not possible to devise a perfect scheme which is applicable under all conditions. The important point is rather that we now have a fair understanding of the primary factors which produce agricultural differences in soil and that the use of these in the classification, representation and study of soils is of great practical value. We shall attain nearer a perfect system as we accumulate more information on the subject. All of the elements of soil separation which are mentioned in the following pages have been employed in the work of the Bureau of Soils, but they have not been given equal or uniform value.

The most comprehensive review of the methods which have been used in the classification of soils is that by Coffey prepared as a thesis for the doctor's degree in George Washington University under the direction of Dr. George P. Merrill.

The aim of this paper is to organize the factors which have been used in the classification of soils and any others which appear to have a controlling influence on the agricultural value of soil into a scheme which shall point out the fundamental factors involved, and the relation of these factors to the distribution of soils in the field. The requisites and some of the limitations of such a scheme have been stated. It was noted that the crop-producing power of a soil is dependent upon its chemical and physical properties and the climate.

Statement of Plan of Classification.—The climate of a soil has two phases: First, the climate of the region in general, due to its geographic position. Second, the climatic conditions within the soil, due to the physical and chemical properties of the soil itself. Due to the latter two soils of different properties situated under the same general climatic conditions may present different climatic conditions to the plants growing upon them. The temperature and humidity of sand and clay may be very different, which is illustrated by the fact that one is termed an "early" soil and the other a "late" soil.

The physical and chemical properties of a soil are due to its mode of formation and the kind of materials used. The first include the time element or extent of operation of the processes and changes subsequent to the general formation of the material such as drainage, climate, etc. The second include the kind of rocks from which the soil material is derived and may be as diverse as the kinds of rock multiplied into the proportionate mixture of any combination of these. The scheme is, therefore, genetic and in its broader lines purely geological. The relation of these to agri-



cultural properties will be indicated as the scheme is developed.

Climate.—The broadest agricultural divisions in soil are due to climate. Although the soil material were the same (if that is possible), if it occurred under widely different conditions of climate it would have a different agricultural value and should be differentiated.

Climate consists of two primary elements. These are temperature and humidity, or precipitation.

I. *The Region. Temperature.*—We propose to term the groups of soils determined by temperature the *region* and the surface of the earth would be divided into belts or zones corresponding in general to these commonly made, and these may be multiplied if their agricultural diversity proves too great. The temperature has some influence upon the type of processes by which soils are formed and the changes which they are continually undergoing.

II. *The Section. Humidity.*—The groups determined by humidity we would term the section and the temperature zones would be subdivided according to the degree of aridity. In the United States three conventional groups have been recognized, namely, the humid, the semi-arid and the arid. Humidity has an especially marked effect upon the processes of soil formation and brings about distinct physical and chemical differences. In a general way in arid regions physical processes of the decay of rocks are relatively more prominent than chemical processes, resulting in soil which averages coarser in texture. Alkali or the excess of soluble salts is chiefly identified with aridity of climate. These are, therefore, broad distinctions in the properties of soil which should be recognized.

III. *The Province. Mode of Formation.*—The third great factor which determines the properties of a soil is the mode or process of formation. This includes all the processes and forces which have been operative in transforming rocks into soil and imparting to them distinctive physical and chemical characteristics. These are dynamic and, therefore, impress special properties upon the material handled. While several processes are usually operative on the same material, they are seldom equally prominent, and certain conventional groupings have been adopted by

geologists, especially those who have given much attention to soils, for example, G. P. Merrill.[8] These are (*a*) general weathering which gives rise to residual material. The type of weathering and the activity of the several forces will depend upon the kind of rock. (*b*) Decay acting upon organic material to give rise to cumulose deposits. It differs from weathering, since there is an actual building up of material due to biological activity and biological changes are dominant. These two groups taken together have been termed the *sedentary division,* since the material has not been appreciably moved. Where rocks are involved the soil is likely to rest on rock of the same kind as that from which the soil was formed. The physical as well as the chemical properties of the rock maintain much of their identity in residual soil—for example, quartz bands in gneiss rock and chert masses and other impurities in the different strata of limestone.

The remaining processes involve appreciable transportation of the material and have been grouped together as the *transported division.* Four great agencies of transportation are recognized.

(*c*) Gravity produces the slow sliding of material down rather steep slopes and in some instances it includes avalanche movement. The material is without organized structure and likely to be rather coarse and thin and of low agricultural value in both extent and adaptation.

(*d*) Water has been the great transporting and soil-forming agency. Many of the most famous agricultural portions of the earth owe their formation to water, notably the Nile Valley, the American coastal plain and the interior lake plains and stream valleys. It couples a wide range of transporting power with very decided sorting and in the deposit of the material produces stratification. Thereby nearly all of the areas of soil of distinct textural unity have been derived. Fine clay and clean, uniform sand are equally identified with the agency of water. Stratification implies differences in successive layers, and a shift in the direction or velocity of movement of the water when a material was being laid down may produce great variation in texture, structure and chemical composition. These principles of variation are so well understood that much explanation is unnecessary.

It is worth while to recognize three phases of action of water according to its breadth, extent of movement and to some degree its character. These are oceans (saline waters), lakes and streams. The depth, uniformity and chemical character of the soil formed under each of these influences are likely to be distinct. While water gathers rock material from many sources, each body is likely to have certain characteristics of its material due to the region drained.

(*e*) Ice in the form of glacial masses has been an extensive and important agency of soil-formation adjacent to the polar regions and in high mountains. Some of the most famous agricultural portions of the world, such as much of the Upper Mississippi River Valley owe their character to this agency. Here again peculiar chemical, physical and, to some extent, topographic features are imparted to the material handled. The kind of rock encountered, the rate and direction of movement of the ice and the minimum of chemical decay and leaching have determined the agricultural features of many regions formed by glacial ice. The soil conditions in New York State especially exemplify these distinctions.

Ice does not accomplish sorting or strati-

[8] Merrill, G. P., "Rocks, Rock-weathering and Soils," pp. 411, 1897, Macmillan Co., N. Y.

fication and is likely to produce a range in texture and a degree of compactness of the lower part of the soil section not found in soils formed in other ways. It is often difficult to distinguish between material deposited by pure ice action and that modified by glacial water due to the melting of the ice.

(*f*) Wind has not been so distinctively a soil-forming agency as water and ice, though it has very generally contributed to the result.[9] Like water it effects sorting and stratification, but the range in texture of material carried is very much more narrow, the type of stratification is different, and the material has a wider areal unity in chemical and physical properties. The most distinctive soil formations whose origin has been referred to the action of wind are sand dunes and loess. The former represents a large amount of material which has been rolled along the surface of the ground. It is usually a fine sand and shows sorting to the extent that very fine material is almost wholly removed. While the origin of loess has been referred to the settling of dust from the atmosphere, the American deposits exhibit properties which cause the adequacy of this theory to be questioned. In northern China, where this material was first recognized, its origin was attributed by Von Reichtofen to the agency of wind. At any rate it is a distinct material and seems more closely associated with this mode of formation than any other. The possible chemical and physical properties of wind-blown material entitle it to recognition in the scheme of classification.

IV. *The Group—Source of Material.*—The kind of rock from which a soil is formed is generally recognized to have a large influence on its chemical and physical properties. The mineral character of the rock and the extent of decay determines the texture of the soil. The composition of the rock influences both the composition and texture of the soil in a distinctive way. The same rock may be transformed into soil by several agencies and again the same agency may act on several kinds of rock. The product is likely to be equally diverse in its capacity to support plants. A large variety of rocks might be recognized as influencing the character of soils. The fact that soil has usually been derived from quite a variety of rocks, makes it necessary to keep the divisions here as broad as possible, since only such can be recognized with any degree of accuracy. These are rather large groups and in practise special distinctions are likely to be made on this basis. The primary groups to be recognized may be mentioned as acid and basic rocks of igneous origin, and with these the gneisses, schists and similar secondary rocks are likely to be included; shale and slate, sandstone and quartzite, limestone and marble. Plant remains constitute a separate and distinct class of material from which soil may be formed and the proportion of these which enters into any given formation may give distinctive character.

Often the mingling of material from several kinds of rock may impart peculiar character to the soils of a drainage system or a lobe of glacial ice. The red alluvial soils of the Red River drainage system owe their character largely to the red Permian formations of Oklahoma and Texas. The glacial soils of west central New York are largely dependent for their character upon the several shale, limestone and sandstone rock formations crossed by the ice in reaching that position. The line of movement of the material with reference to the gen-

[9] Free, E. E., "The Movement of Soil Material by the Wind," Bul. 68, Bureau of Soils, U. S. Dept. of Agriculture, pp. 272, 1911.

eral rock structure will largely determine the relation of the soil to any particular rock formation.

V. *The Series.*—The soil series is the most complex of the separations made in practise. Unlike the others, it does not rest upon a single character. Its separation requires the employment of a group of correlated characters. These are more intimate in their nature, more concerned with the material itself than the bases of the larger separations. Having applied those, the final grouping of types or units is determined first of all by

(*a*) *Color.*—Color as a physical property is not of great importance, but when considered in connection with the properties which are correlated with color it is of the greatest significance. Color is usually indicative of the proportion of organic matter, of the drainage, of the state of oxidation, of the proportion of lime carbonate and to a degree of the mineral composition of the soil.

(*b*) *Organic Matter.*—The proportion of organic matter is suggestive of the nitrogen content of the soil. It has a large influence on the availability of the mineral particles. It is indicative of the natural drainage, of the proportion of lime carbonate and of the activity and type of microorganisms.

(*c*) *Lime Carbonate.*—The presence of a fair amount of this constituent has been pretty generally recognized as essential to a fertile soil.

(*d*) *The Total Plant Food Content of the Soil.*—While the average soil contains a relatively large quantity of the mineral plant food constituents, soils which are decidedly deficient in some one or more of these are sufficiently abundant to warrant the special consideration of this property. It does not necessarily involve general chemical analysis and may often be inferred from other properties. The solubility of the soil constituents, while seldom a distinctive series basis of separation, is often indicative of other characteristics of the soil and as alkali, especially, of the type of climate. These several elements will seldom, if ever, have equal value in deciding a separation. They can not well be applied independently in general field work. In some cases one, as color, may be dominant; in another drainage, and in still other separations it may be the lime content which will determine the grouping.

If one consider all soil series together without reference to their grouping according to the broader bases of classification, such as formation, etc., it will generally be observed that soil series are chiefly distinguished by chemical differences, that is, differences in composition and chemical form. Organic matter is suggestive of the nitrogen content, solubility, etc. The presence of lime is a matter of composition. Differences in rock material mean certain differences in composition. On the other hand, the last or unit separation of soils is based chiefly on physical properties—texture and structure. The series includes all material having the same characteristics, but varying in texture from the coarsest to the finest.

VI. *The Type. Texture and Structure.*—The fineness of the material of which a soil is composed is the most broadly influential of the physical properties of a soil. Through its influence on porosity, moisture relations, aeration, temperature, tillage properties, etc., it is probably the most dominant in deciding crop adaptation and agricultural value. The more distinct textures of clay, loam, silt and sand are generally recognized. These rest upon the proportion of particles of different sizes and a great variety of proportions may be recognized and given names. These are

being multiplied. A question requiring further consideration is the number of sizes of particles—separates—to be recognized and the limits of these. Several systems of groupings are now in use.[10] The finer the particles the greater is the influence of a given mass of them upon the character of the soil. Many more divisions should, therefore, be made in the fine material than in the coarse material. It is an open question whether, as survey work has been done in the United States, sufficient divisions have been made below the sand classes. Undoubtedly field separation of materials by hand examination is not likely to be more refined than is possible with the divisions now generally made. However, finer distinctions in the mechanical analysis of material smaller than 0.005 mm. may explain some variations in types of soil not otherwise recognized and these form the basis for more detailed study of individual types.

The structure of a soil as determined by the order of stratification and the thickness of the layers may also be the basis of type separation. This is independent of general structural differences due to the general mode of formation and the characters of the rock.

The soil type is the unit for soil study and should be as nearly alike in all parts as is possible. It is the most important grouping of material primarily because it does represent the chief physical differences in soils. The next most important grouping is the soil series and these two will be most generally identified with particular crop and agricultural interests in practise. This does not minimize the value of the larger separations, which, as has been suggested, are essential to reasonable accuracy in these last two groups.

[10] Briggs, L. J., et al., "The Mechanical Analysis of Soils," Bul. 24, Bureau of Soils, U. S. Dept. of Agr., 1904.

Of course the final test of a survey must be in the field man who applies these principles to a particular set of conditions. Owing to the intimate overlapping of several fields of natural science in this work it is evident that he should be a man of broad training, including especially geology and the principles of soil fertility, and he should have keen power of observation and correlation. Scarcely any experience or training which the field man may possess but finds use in the ideal soil-survey man.

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THE BRITISH ASSOCIATION

A preliminary program has been issued for this year's meeting of the British Association, which, as already announced, is to take place at Dundee from September 4 to 11. The meeting will be the eighty-second of the series, the twelfth in Scotland, and the second in Dundee, the association having previously met in that city in 1867.

The opening meeting will be held in the Kinnaird Hall on Wednesday evening, September 4, when Professor E. A. Schäfer, F.R.S., will assume the presidency and deliver his inaugural address. In the same hall the first evening discourse will be delivered on Friday, September 6, by Professor W. H. Bragg, F.R.S., on "Radiations Old and New," and the second on Monday, September 9, by Professor A. Keith, on "The Antiquity of Man." The reception room and offices will be established in the Albert Institute, and a considerable proportion of the sections will have their meeting-rooms in the University College.

Arrangements have been made with the railway companies for the issue to members of return tickets at reduced fares, available for the period of the meeting and eight days after, and excursions during and after the meeting, for the purposes of scientific field-work, are expected to prove particularly important this year. The famous Alpine flora of Clova and Glenesk, the fossil fish beds of Dura Den, and the geology of the Stonehaven region and of the Western Highlands

are among the objects of contemplated visits. The President will have the assistance of a body of vice-presidents representative of the administrative, educational, ecclesiastical and commercial interests of Dundee and its neighborhood, headed by the Lord Provost of the city, Mr. James Urquhart, LL.D., and in the notice of entertainments to be arranged in connection with the meeting the names of the Earls of Moray, Strathmore and Camperdown and of Lord Kinnaird appear as hosts.

PENSIONS AT THE UNIVERSITY OF CHICAGO

As has already been noted in Science the trustees of the University of Chicago have arranged a system of retiring allowances, and for this purpose propose to set aside a sum not less than $2,000,000. The trustees do not reserve the power of altering the statute to the disadvantage of those in the service of the university at the time it was enacted. The full statute reads as follows:

1. Any person in the service of the university and sixty-five years of age who holds the position of president of the university, director or associate director of the university libraries, or university examiner, and who has been for a period of fifteen years in the service of the university, in a rank not lower than assistant professor; and any person in the service of the university and sixty-five years of age, who has been, for a period of fifteen years in a rank not lower than assistant professor, a member of the teaching staff of the graduate schools of arts, literature and science, the graduate divinity school, the law school, or the colleges, may retire from active service, or be retired by the board of trustees on an annual allowance to be computed as follows:

(*a*) For fifteen years' service, 40 per cent. of the average annual salary received during the five years immediately preceding the time of retirement.

(*b*) For each year of service beyond fifteen years, 2 per cent. of the said average annual salary.

But no annual allowance shall exceed 60 per cent. of the said average annual salary, nor shall it exceed $3,000.

A person between sixty-five and seventy years of age, eligible to a retiring allowance, may retire, or may be retired by the board of trustees; at the age of seventy years he shall retire, unless the board of trustees specially continues his service.

2. The widow of any person in receipt of, or eligible to, a retiring allowance at the time of his death, shall be entitled to one half of the amount of his allowance during the period of her widowhood, provided she was his wife at the time of his retirement and had been his wife for not less than ten years before his death.

3. No right or claim under this statute shall vest in, or accrue to, any person until a retiring allowance shall become due and payable under and in accordance with it; and the exercise of the right or power of the board of trustees to terminate the service, or reduce the salary, of any person shall not give to such person any claim or cause of action hereunder against the university.

4. The board of trustees reserves the right to suspend the retiring allowance of any person, who, while in receipt of such allowance, accepts an appointment on the staff of any other institution of learning.

5. The obligation of the university to pay retiring allowances shall be neither greater nor less than its obligation to pay salaries to persons in active service, so that if misfortune should compel a percentage reduction of salaries, retiring allowances may be reduced in the same proportion.

6. Nothing in this statute shall preclude the board from granting other retiring allowances, or allowances on account of disability to officers of administration or instruction, or their widows, where the term and character of service, or the special circumstances of the case make the same appropriate, or from adding a term of years to the actual years of service of a person who enters the service of the university as an associate professor or of higher rank.

7. The board of trustees retains the power to alter this statute, but the alteration shall not have any effect as to persons of the class or rank mentioned in Art. 1, at the time of such alteration.

SCIENTIFIC NOTES AND NEWS

Mrs. Mary Maury Worth, of Richmond, Va., and other descendants of Matthew Fontaine Maury, the eminent hydrographer, have presented to the United States through President Taft the Maury medals, commissions and correspondence.

Dr. Karl Chun, professor of zoology at Leipzig, has been awarded by the University

of Göttingen the prize of the Otto Vahlbruch foundation, of the value of $3,000.

Dr. Pietro Albertoni, professor of physiology in the University of Bologna, has been elected a member of the Italian senate.

Dr. A. Hrdlička, of the U. S. National Museum, has been named a corresponding member of the Société d'Anthropologie de Bruxelles, Belgium.

Professor Fürbinger, the director of the anatomical institute at Heidelberg, retires at the close of the summer semester and is succeeded by Professor Braus.

An expedition for the study of malaria from the department of tropical medicine and hygiene of Tulane University, under the direction of Dr. Charles Cassedy Bass, sailed from New Orleans on April 20 for Central America.

Dr. Marcus Benjamin has just been informed that his valuable collection of the portraits and autograph letters of the presidents of the American Association for the Advancement of Science received the award "diploma d'honore" from the exposition that was held in Turin, Italy, last summer.

Dr. Amos W. Peters, of the Carnegie Food Laboratory in Boston, has been appointed biochemist in the research department of the Training School for Feeble Minded Children, at Vineland, N. J. So far as is known this is the first appointment of the kind ever made. Five years ago, the Vineland Training School opened a department of research for the scientific study of mental defectiveness of which Dr. Henry H. Goddard was made director. Studies in growth, heredity, classification of defectives, the measurement of intelligence have been carried on and now the work is being extended in other lines. Dr. Peters has worked in zoology and biochemistry at the University of Illinois and later at the Harvard Medical School with Dr. Otto Folin. He will carry on studies in metabolism and brain chemistry. He will begin the new work about July 1.

Among recent lectures of scientific interest at the University of Illinois are the following: three lectures on "Heredity," by Professor W. E. Castle, of Harvard University; "The Paleozoic History of Illinois," by Dr. T. E. Savage, of the Geological Department of the university; "Foreign Students and Student Life at the University of Berlin," by Dr. Wilhelm Paszowski, of the University of Berlin; "Morals and Moral Ideals of the Japanese," by Professor Inaze Nitobe; "Some Methods that have been tried in University Business Organization," by Dr. H. C. Bumpus, business manager of the University of Wisconsin; "European Bridges," by Professor F. O. Dufour, of the department of civil engineering.

A joint meeting of the Columbus Section of the American Chemical Society with the Ohio State University Sigma Xi Society was held on April 17, when the address of the evening was delivered by Professor R. A. Millikan, of the University of Chicago, on "New Proof of the Kinetic Theory of Matter and of the Atomic Theory of Electricity."

Before the Society of Sigma Xi of Columbia University, Professor Henry E. Crampton gave on May 2 an illustrated lecture on "A Zoologist's Trip to South America."

Associate Professor James R. Withrow, of the Ohio State University chemical department, recently delivered a lecture before the Kenyon College Chapter of the Phi Beta Kappa, on the "Destructive Distillation of Heartwood."

On returning to Europe in September Captain Raold Amundsen will make his first address before the Norwegian Royal Geographical Society in Christiania. A few days later he will lecture before the Royal Geographical Society in Berlin, then in other cities in Germany, Austria and Switzerland. On November 18 he will address the Royal Geographical Society, London.

Dr. Howard T. Barnes, MacDonald professor of physics in McGill University, will lecture before the Royal Institution of Great Britain on May 31, on Icebergs and their Location in Navigation.

The Rev. George William Knox, professor of philosophy and the history of religion in the Union Theological Seminary, died on April 25, at the age of fifty-nine years.

Professor Charles Henry Chandler, emeritus professor of mathematics at Ripon College, died, on March 29, from heart failure, at the age of seventy-one years. He graduated from Dartmouth College in 1868, taught at Antioch College from 1871 to 1881, and at Ripon College from 1881 until his retirement on the Carnegie Foundation in 1906. He was for many years a fellow of the American Association for the Advancement of Science.

The death has occurred of Mrs. Margaret E. Stinson, who for forty-six years was connected with the Massachusetts Institute of Technology, latterly in the care of the chemical apparatus. During her long connection with the institute she assisted and befriended many of the students.

Dr. William Ogle, distinguished for his contributions to vital statistics, died on April 12 at the age of eighty-four years.

The nineteenth summer meeting of the American Mathematical Society will be held at the University of Pennsylvania on Tuesday and Wednesday, September 10–11, 1912.

The Society of American Bacteriologists will hold its annual meeting in New York City at the close of this year.

The next annual meeting of the Biochemical Association will be held at the College of Physicians and Surgeons, Columbia University, on Monday evening, June 3. Besides the usual business meeting there will be a scientific program consisting of the presentation of reports of recent researches by members of the association. This scientific session will be the first of an annual series of similar meetings. Abstracts of the reports will be published collectively in the June issue of the *Biochemical Bulletin.*

Mr. J. B. Tyrrell, the geologist and mining engineer, is to lead the Ontario government expedition into the north to locate the five-mile strip which the province is to receive from the Dominion. Although the route has not been settled, the party will probably proceed first to Winnipeg about the end of May, and thence to Lake Winnipeg to Port Nelson, much of the journey by canoe. At the mouth of the Nelson River, some time will be spent in locating the ten-mile strip which Ontario will have as a terminus for the Temiskaming and Northern Ontario Railway, should it be decided to extend the line there. The party will then head for the south, and a larger part of the five months will be taken up in exploring the 50-mile stretch along Hudson Bay, anywhere in which the government has a right to choose its five-mile strip.

Professor C. H. Eigenmann, of the Indiana University and the Carnegie Museum, after a successful exploring trip on the rivers of Colombia, returned by the *Alemania* on April 15. The main object of this expedition was to secure a series of the fishes of Colombia. After collecting in the lower courses of the Magdalena River, he ascended that river to an elevation of one thousand feet at Girardot. From here a side trip was made to Bogota. After returning to Girardot, he went by pack-train, *via* Ibagué, Cartago, Cali to Caldas on the Pacific slope. From Caldas he went by train to Buenaventura on the Pacific Coast. In this trip collections were made in all the streams crossed and especially in the Rio Dagua, flowing into the Pacific from an elevation of 5,000 feet to tide water. From Buenaventura he went up the San Juan, first by steamer and later by dug-out canoe with Indians to Istmina. From Istmina the divide between the Pacific and Atlantic slopes was again crossed by horse to Tambo. From Tambo, at first small canoes and later one larger canoe took him and his effects on the San Pablo and Rio Quibdo to Quibdo. As the navigation of all of these streams was very irregular on account of the unusually dry season, special arrangements were made to take him from Quibdo to Rio Sucio where, on account of a scare of pirates, the regular steamer from Cartagena was delayed awaiting the arrival of a company of soldiers from

Cartagena. This brought him to Cartagena on April 2, only three days beyond the date on which he hoped to sail.

On April 20 Governor Dix signed a bill appropriating $500,000 for the rehabilitation of the New York State Library. This makes a total of $622,000 appropriated for this purpose since the destruction of the library by fire in March, 1911. Beyond the fundamental general reference material, the State Library will specialize in science only so far as may be necessary to serve such agencies or departments of the state government as are doing scientific work. Good working collections will be made in geology, zoology, entomology, botany, with more particular attention to the economic phases of these subjects, and in chemistry as related to agriculture, the arts and commerce. The fact that the New York State Museum is administratively connected with the State Library will mean that in the subjects falling within the scope of the museum's work special attention will be given to the establishing of a notable collection of books.

The Smoot bill to consolidate all national parks and monuments under one Bureau of National Parks, has been reported favorably by the Senate Committee on Public Lands. The measure has the endorsement of the Interior Department and the American Civic Federation.

The University of California will establish a temporary outpost this summer in the Yosemite Valley. At the conclusion of the summer session (which extends from June 24 to August 4) the summer students of botany and zoology will go to the Yosemite for two weeks. The botanical students will put into practise the training received at Berkeley, by field studies on the classification and zonal distribution of the flowering plants and ferns in that portion of the Sierra Nevada. Meanwhile those who have had the summer session courses in zoology will study the habits and characteristics and ways of life of the mountain birds and mammals of the Yosemite region. For five weeks during the summer a party of summer session students will be encamped south and east of Mount Diablo, engaged in collecting fossils, identifying extinct animals of which they are the remains, and mapping the faunal zones which record the changes of species over periods of uncounted hundreds of thousands of years. Still another summer outpost of the university will be the Summer School of Surveying, at Camp California, near Swanton in Santa Cruz County. Here some 200 men will be learning how to make maps, survey lands, run railroads and canals and lay out irrigation and drainage systems.

The *Journal* of the American Medical Association states that the originator and president of the recent international hygiene exposition at Dresden, Dr. Lingner, has petitioned the local authorities to establish a national museum of hygiene in Dresden. It is contemplated to use the hall, "Man" (*Der Mensch*), which proved the greatest attraction for visitors to the exposition, as the nucleus of the museum. The museum is to be designed to realize the important principle that every one shall gain by direct inspection the knowledge which will fit him for a sanitary and intelligent conduct of his life. For the completion of this self-instruction, popular weekly lectures are to be held, which will gradually cover the entire field for the care of health. In addition, the management of the museum shall provide scientific lectures and demonstrations for professional people, that is, for physicians, officials, engineers and the leaders of industry. An academy of scientific character is also proposed to supplement the museum. Lingner will present to the museum the objects exhibited at the exposition, which represent a value of $250,000. The land, which is reckoned at about 6,000 square meters, is to be donated by the city of Dresden. The expense of building and furnishing are reckoned at about $875,000. The expense of building will be defrayed first out of the surplus from the international hygiene exposition, amounting to $250,000, while the government of the province (Saxony) will give the rest. The annual expenses are estimated

at about $62,500. Of this, the city of Dresden will furnish $37,500; the special income of the museum from entrance money and fees for attendance at lectures, etc., is estimated at $20,000. The rest, it is hoped, will be supplied by gifts. The museum is to include three chief divisions, "Der Mensch," the historical division and the ethnologic division.

UNIVERSITY AND EDUCATIONAL NEWS

NEARLY two hundred thousand dollars have been subscribed to the equipment fund in the past two weeks, according to the announcement of the Alumni Fund Committee of the Massachusetts Institute of Technology.

THE Sheffield Scientific School of Yale University has received from Mr. Murray Gugenheim, of New York City, $20,000 as a nucleus of a fund for additional instruction and equipment in the branches of mining and metallurgy.

BY act of legislature of the state of Pennsylvania, dated April 20, a charter of incorporation, with the power to grant degrees, was given to the Carnegie Technical Schools, and the name of the institution is changed to the Carnegie Institute of Technology.

WORK has been commenced upon the construction of the new Ceramics and Mining Engineering Laboratories of the University of Illinois. These buildings are to form a part of the group of engineering buildings to be located upon ground east of Mathews Avenue, which has recently been acquired by the university. The contracts for the new Transportation Building and the Locomotive Testing Laboratory will soon be let.

PROFESSOR FILIBERT ROTH, head of the forestry department of the University of Michigan, who recently accepted the chair of forestry at Cornell, has reconsidered his decision and will remain at Michigan where the regents have agreed to provide additional facilities for the forestry school.

PROFESSOR FREDERICK E. BOLTON, professor of education and director of the school of education in the State University of Iowa, has accepted a call to become head of the department of education in the State University of Washington at Seattle, and will begin his work at that place in September.

DR. ROBERT CHAMBERS, JR., has accepted an appointment as assistant professor of histology and embryology in the University of Cincinnati. Dr. Chambers is on the teaching staff of the Marine Biological Laboratory, Woods Hole, Mass., and has held the position of lecturer in the University of Toronto for the last three years. He now has a fellowship in Professor E. B. Wilson's department.

DISCUSSION AND CORRESPONDENCE

THE NAME AND BRAIN OF THE GAR

TO THE EDITOR OF SCIENCE: From my former pupil and assistant, Asa C. Chandler, A.B., now on the staff of the University of California, I have recently received a copy of his paper, "On a Lymphoid Structure Lying Over the Myelencephalon of *Lepisosteus*," constituting No. 2 of Vol. 9 of the "Publications in Zoology" edited by Professors Ritter and Kofoid of that institution. Every such contribution to the knowledge of this genus is to be welcomed as helping to remove the "reproach to the comparative anatomists of this country that the brain of this [almost] exclusively American form should not have been fully elucidated."[1] Material and literature for the profitable discussion of the structure and homology of the newly described organ are now inaccessible; but a careful

[1] The sentence here quoted is from my review of Wiedersheim's "Comparative Anatomy of Vertebrates," SCIENCE, N. S., Vol. 27, May 8, 1908, under the caption, Fig. 159. The bracketed word is introduced in qualification of the too sweeping statement as to the distribution of the genus; according to Jordan and Evermann it is represented in China by a single species, *L. sinensis*. Never having seen an example of this species, or even a picture or description of it, I had forgotten its existence not only when the sentence quoted was written, but also when trying to enumerate my errors ("Some Mistakes of the Writer and Others," etc., SCIENCE, N. S., Vol. 34, July 21, 1911). Are the other readers of this journal equally ignorant, or forgetful, or simply indifferent, or needlessly sparing of my feelings?

reading of the paper has led me to make some notes which I should submit to the writer were we still associated and which I hope will not be without interest and profit to others.

1. *The Generic Name of the "Gar."*—Mr. Chandler and the editors adopt *Lepisosteus* as introduced by Lacépède in 1803 rather than *Lepidosteus* as corrected by the elder Agassiz and—till lately—almost universally employed. With all admiration for President Jordan (another former pupil who, I think, suggested or at least sanctioned the change), I feel that this is too rigid an application of the "priority rule." Had an ignorant or heedless person first christened the "duck-bill" as *Ornisorhynchus* should we have perpetuated a blunder that would offend all scholars? I doubt it. Conceding, however, that in this matter each has a right to his own opinion and usage, I protest against the change in the title of my paper, "On the Brains of *Amia*," etc.,[2] where the original *Lepidosteus* is converted into *Lepisosteus*. I hold that the latter form has no etymologic standing, and—excepting in quotation—would no more use it than a profane expletive.

In this connection it may be properly mentioned that the specific name of the "alligator gar" is not *tristœchus*, as used by Mr. Chandler on p. 87, but *tristœchus*, from στοῖχος.

2. *The Contour and Constitution of the Gar's Brain.*—The dorsal aspect is represented in the text-figure *A*. It is very unlike the corresponding figure of Balfour and Parker as reproduced by Wiedersheim. Although I have exposed several gar brains, unable now to refer to them, I will not undertake to say which of these figures is the more nearly correct; possibly difference of species or age may account for some discrepancies, certainly not for all. Chandler's figure contains no indication of the thalamic region (diencephalon or "thalamencephalon") or explanation of its omission. The outline is represented by a continuous line; it should be interrupted at the place of emergence of the olfactory nerves even if the nerves themselves are omitted.

[2] Amer. Asso. Adv. Sci., Proc., 1875.

3. *The Names of the Parts.*—Why should the two cephalic ("anterior") pairs of lobes be designated as "anterior" and "posterior lobes of the cerebrum" when there can be no doubt that the first pair are the hollow olfactory bulbs and the second the solid striata (unfortunately called "prothalami" by me in 1875)? And since the, so to speak, "specific" names of these two parts, of the "optic lobes," and of the "trilobed cerebellum," were deemed adequate for their designation, and since the segmental constitution and names were in no way concerned in the general treatment of the subject, why should the region supporting the newly described lymphoid structure be singled out for the application of the ponderous title, "myelencephalon" when "oblongata" or "medulla oblongata" would have sufficed? "Oblongatal gland" would be unobjectionable. Excepting, perhaps, his own coinage, "Isthmus rhombencephali," for a region since commonly admitted to be non-existent or negligible, *myelencephalon* is one of the most objectionable components of the neurologic nomenclature selected by the late Professor His, adopted by the Anatomische Gesellschaft, and blindly, hastily or slavishly employed by many in this country. Its only logical justification would be the adoption of Owen's "myelon" in place of "medulla spinalis." Even if myelencephalon is preferred, should not "metencephalon" have been added as a synonym? It is a more appropriate equivalent of Von Baer's "Nachhirn"; it is quite as familiar to most anatomists; it was preferred by the majority of the committee on nomenclature of the Association of American Anatomists in 1897; and, as has been pointed out by me on several occasions, the prefix lends itself readily to useful and euphonious compounds, *metacele, metaplexus, metatela* and *metapore* ("Foramen of Magendie"). These considerations render me hopeful that when there comes a subsidence of "Hisolatry" and of the prevailing obsession of most American anatomists for ideas and words "made in Germany," the last encephalic segment will be known as *metencephalon* and the last but one as *epencephalon*.

To offset in some measure the foregoing criticisms of the terminology of Mr. Chandler's paper let me commend his use of pial, dorsal, caudad and cephalad.

BURT G. WILDER

A FISTULA IN THE DOGFISH

IN a shipment of dogfish pups (*Mustelis canis*) sent from Woods Hole to the Biological Laboratory of New York University during the summer of 1910, there was a specimen about 20 inches long with a cœlomic fistula which had been closed in a curious manner. The opening was on the ventral surface, just posterior to the left pectoral fin. Externally it was not conspicuous, the tissue of the oval scar being much the same color as the surrounding skin, although evidently of a somewhat different texture.

On laying open the body cavity it was found that the fistula had been plugged by a growth from the left lobe of the liver, which had filled the wound completely without adhering to the structure of the body wall. The edge of the cicatrice, after the liver had been drawn away intact, was smooth and thoroughly healed.

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NOTE ON "SOME EARLY PHYSIOGRAPHIC INFERENCES"

AMONG the interesting physiographic comments quoted from early writers by Dr. Emerson on page 374 of SCIENCE for March 4, the one by James Hall is evidently misinterpreted. The quotation is as follows:

> About midway between St. Louis and the mouth of the Ohio, masses of limestone rock are seen on either side, which, though now unconnected, have the appearance of once having formed a continuous ridge crossing the river in an oblique direction.

This is supposed by Emerson to refer to the bluffs bordering the new trough of the Mississippi River near Thebes, Ill., where it leaves its old valley and crosses into another formerly occupied by the Ohio River. It seems practically certain, however, that Hall had in mind a conspicuous ridge of limestone beds dipping steeply northeastward, which appears on the west bank of the Mississippi in Perry county, Mo. Just below Wittenberg, this ridge has evidently been obliquely intersected by the river, the obvious southeastward continuation in a direct line appearing on the east bank in the picturesque series of isolated rock masses known locally as the Devil's Bakeoven and Devil's Backbone; the latter ending abruptly at the town of Grand Tower, Ill. This is about three fifths of the distance from St. Louis to the Ohio, while the Thebes cut is only a short distance above the mouth of the Ohio; and at the cut neither the rock masses nor the oblique direction are especially evident.

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SCIENTIFIC BOOKS

The Mechanical Factors of Digestion. By WALTER B. CANNON, A.M., M.D., George Higginson Professor of Physiology, Harvard University. Illustrated. London, Edward Arnold; New York, Longmans, Green and Co. 1911. Pp. 227.

The motor activities of the muscle tube which forms the digestive system has long been a favorite subject of investigation, and a considerable mass of valuable information is at our disposal. But this evidence often shows a marked lack of harmony, even though the observations were made upon the same organ in the same animal. The fault, however, lay not so much with the experimenters, as with the methods employed; there was no single procedure which was applicable for the study of the entire gastro-intestinal canal without grave operative interferences, and these interferences often altered or even abolished the very function which was to be investigated. It was therefore natural that varying interpretations and consequent confusion should arise. In 1896, a method was developed by means of which the motor functions of the entire digestive tube, from pharynx to rectum, could be observed without

any operation whatsoever; or the effects of operations (resection of nerves, portions of the gut, etc.) could be studied after the animal had fully recovered. Cannon achieved this result by means of the X-ray. This method depends on the fact that food mixed with a salt of bismuth (subnitrate or oxychloride; an iron salt has also been used lately) becomes opaque to the X-ray. If the subject under investigation, man, dog, cat or other animal, ingests this bismuth paste, the bolus may be observed on the fluorescent screen, for the bismuth mass blocks the X-rays and betrays its presence to the observer by a vibrating shadow on this screen. The progress and change in shape of this shadow disclose to the eye of the expert observer the character of the muscular activity of the digestive system.

Besides originating and perfecting this method Cannon has also been the foremost modern investigator of gastro-intestinal motility. The experimental results with which he enriched physiology during the last fourteen years have, however, only recently been collected by him in a monograph, and this monograph is the first authoritative attempt to give a complete, critical study of motor digestive activities as a whole, using as a guide the results gained by his new method. Although Cannon's work forms by far the largest part of our modern knowledge of the motor activities of the gut, his monograph is by no means a one-sided presentation of the results obtained by his laboratory; other important work, gained by various experimental methods, is critically considered and brought into relation with the direct testimony which the X-ray affords.

The entire subject matter is considered by Cannon in sixteen concise chapters, and the chapter headings will indicate to the reader how completely the field has been covered. I., General Features of the Movements of the Alimentary Canal, and Methods of Investigation; II., The Movements of Mastication and Deglutition; III., The Nervous Control of Deglutition; IV., Conditions Affecting the Activities of the Cardia; V., The Movements of the Stomach; VI., The Effect of Stomach Movements on the Contents; VII., The Stomach Movements in Relation to Salivary Digestion and Gastro-enterostomy; VIII., The Passage of Different Foodstuffs from the Stomach; IX., The Acid Control of the Pylorus; X., The Correlating Functions of the Pylorus, and some Conditions Affecting It; XI., The Movements of the Small Intestine; XII., The Movements of the Large Intestine; XIII., Auscultation of Gastro-intestinal Sounds; XIV., The Intrinsic Innervation of the Gastro-intestinal Tract; XV., The Extrinsic Innervation of the Gastro-intestinal Tract; XVI., Depressive Nervous Influences Affecting Gastro-intestinal Movements. At the end of each chapter a complete list of the more important literature references is given, and this list will be a great convenience for many research workers.

While these chapter-headings show the scope of the book, they give no indication of their interesting, and attractively presented, contents. Although it is not possible here to discuss all the valuable and interesting sections of the book, and they will be found in every chapter, attention may be called to Cannon's theory of the acid control of the pylorus. The pylorus, a sphincter muscle which guards the opening of the stomach leading to the intestine, regulates the passage of the food into the duodenum (upper part of the small intestine). Depending upon the character and state of the food in the stomach, this gatekeeper feeds at intervals a spurt of food into the gut. By what mechanism is this accomplished? How can this ring of muscle-fibers differentiate, for example, between carbohydrates, which are permitted to leave quickly, and proteids, which remain for a considerable period of time in the stomach?

This remarkable behavior of the pylorus was first explained satisfactorily by Cannon, and his theory, in brief, is as follows: Free acid above the sphincter causes a relaxation of the muscle ring and a peristaltic wave is thus able to discharge a quantity of chyme into the duodenum. But as soon as the chyme reaches the duodenum, its acidity produces a closure of the pylorus. The acidity of the

chyme, however, is soon neutralized by the alkaline bile and pancreatic juices, and then the free acid in the stomach produces again an inhibition of the sphincter tonus and another quantity of chyme is driven out. This hypothesis has been tested by Cannon in numerous ways. He has shown, for example, that anything which delays the appearance of free acid delays the onset of the discharge from the stomach; that hastening the appearance of free acid hastens the time of discharge; and by means of a fistula, he was able to observe that the appearance of free acid closely precedes the first gastric discharge into the duodenum. In addition, Cannon showed that free acid causes opening of the pylorus in the *excised* stomach of a cat, thus proving that the control of the pylorus is independent of the central nervous system and resides probably in the local nerve plexus. Free acid, therefore, above the gastric sphincter causes it to relax, and this explains why carbohydrates leave the stomach much earlier than proteids, for both these food-classes stimulate the secretion of gastric juice, as Pavlov has shown, but the proteids unite with the acid as it is produced, forming acid albumen; there is thus no free acid available for a considerable period of time, and, as shown above, free acid is necessary to cause a relaxation of the pylorus. There is no such difficulty with carbohydrates; as soon as the free acid appears the pylorus relaxes, and the crackers, potato-mush, or whatever carbohydrate was fed, is at once transferred to the gut by the peristaltic waves of the stomach.

The evidence that free acid *below* the sphincter, in the duodenum, causes closure of the pylorus, is just as conclusive, for various investigators had shown that acid in the duodenum slows the output of chyme from the stomach, and this must be due to an effect on the pylorus, for Cannon demonstrated that gastric peristalsis was not stopped during this condition. Another support was furnished by the observation of Pavlov that acid solutions leave the stomach much more slowly in dogs with a pancreatic fistula than in normal animals. This is easily explained by the fact that absence of the alkaline pancreatic juice permits the chyme to remain acid in the duodenum for a longer period, and thus the stimulus which causes closure of the pylorus remains effective until the food material becomes neutral or alkaline. Cannon studied the effects of ligation of the larger pancreatic and bile ducts on the rate of discharge from the stomach and gives a chart which shows the marked delay caused by this interference. The stimulus which causes the closure of the pylorus is mediated through the myenteric nerve plexus, for after severance of the entire muscular coats of the duodenum just below the pylorus, Cannon found that the discharge of the stomach content was considerably more rapid than in normal animals: the acid chyme undoubtedly still produced its usual stimulus in the duodenum, but this stimulus could not reach its destination, the pyloric sphincter, because its path had been destroyed.

From the foregoing it will be seen that Cannon's theory seems adequately and simply to explain one of the most remarkable functions in the body, and it is of theoretical interest that the same agent may exert diametrically opposite effects, the sign of this effect being dependent upon the locus of the stimulation.

It may be said, in short, that this concise monograph by Professor Cannon gives a balanced and authoritative view of the present state of our knowledge regarding the motor mechanism of digestion under normal and experimentally modified conditions. In addition, the reader will find that the presentation is lucid and that dogmatic statements are absent.

John Auer

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CHEMICAL TEXT-BOOKS

The Elements of Qualitative Chemical Analysis with Special Consideration of the Application of the Laws of Equilibrium and of the Modern Theories of Solution. By Julius Stieglitz, Professor of Chemistry in the University of Chicago. Parts I. and II. Fundamental Principles and their Ap-

plication. Parts III. and IV. Laboratory Manual. New York, The Century Co. 1911.

As the appearance of Ostwald's "Foundations of Analytical Chemistry" in 1894 showed the way by which it would be possible to transform analytical chemistry from a somewhat mechanical process to a scientific system based on definite laws, and as the investigations of A. A. Noyes and Bray furnished the facts necessary to enable one to select the methods most exact and rapid, so the appearance of this work has marked a milestone in the progress of the science of qualitative and quantitative analysis. In this work the author has collected and applied the observations and deductions which have resulted from the researches of the last score of years in the field of physical chemistry and has furnished a rational explanation for reactions which have hitherto been merely empirical. The work is divided into two parts, the theoretical and the applied. How inspiring it would be if a teacher could always start with a class already trained in physics and mathematics and, with more than the usual time at his disposal, use this method, knowing that he was turning out thinking chemists instead of mechanical analysts. Unfortunately in many cases neither the time nor the previous training of the students is such as will enable him to use this book to advantage, so far as the undergraduate student is concerned, but this is the fault, not of the book, but of conditions governing the methods of instruction and arrangement of courses in different institutions.

Part I. of Vol. I. contains a discussion of the fundamental principles which lie at the foundation of analyses, such as ionization, chemical equilibrium and the law of mass action, osmotic pressure, the colloidal condition and the conditions governing precipitation. All of these questions are discussed in a very clear manner with constant reference to examples in the way of reactions in qualitative analysis. In Part II. we find a general discussion of the methods used in testing for the metallic ions with a detailed statement of each step in the process, great emphasis being placed on the reasons for each step and upon the bearing of the dissociation theory and the law of mass action upon the question under consideration. The theory of the separation of some of the metals by the precipitation with hydrogen sulphide and the theory of complex ions, as well as a discussion of the process of oxidation and reduction, the latter being regarded as involving essentially the loss or gain of electrons, are treated in a very thorough manner.

Although the views here expressed regarding oxidation and reduction may not be generally accepted the subject is admirably presented from the author's point of view.

In Vol. II. we find a discussion of the reactions of the individual metals and acids, especially those reactions which are made use of in qualitative analysis and a very full and clear course in systematic analysis. It would be very desirable if every student of chemistry could follow the course mapped out in this book and work out all the reactions according to the principles given in Vol. I.; but in many instances the time alloted to a course in qualitative analysis is too short to permit the use of such a detailed method.

Every teacher of chemistry and every advanced student of chemistry should study carefully the material contained in this book.

To one who is or is to be a chemist its value can not be overestimated. To the beginner in qualitative analysis its thoroughness and scope should be an inspiration and lead to the very desirable conception of quantitative chemistry as much more than mechanical proficiency in manipulation.

A Handbook of Organic Analysis, Qualitative and Quantitative. By H. T. Clarke, B.Sc. (Lond.), Lecturer on Stereochemistry in University College, London. With an introduction by J. Norman Collie. Longmans, Green & Co.

The Identification of Organic Compounds. By G. B. Neave, M.A., D.Sc. (St. Andrew), and I. M. Heilbron, Ph.D. (Leipzig), F.I.C., Lecturers and Demonstrators, Department of Chemistry, Glasgow and West

of Scotland Technical College. New York, Van Nostrand Co. $1.25 net.

In the first of these volumes efforts have been made to supply the organic chemist with a scheme of analysis and identification of the groups and compounds comparable to the scheme used for the identification of the metallic ions and acid groups. A system of this kind has been greatly needed; but, owing to the great similarity of organic compounds, so far as their constituents are concerned, and to the great diversity, so far as their behavior is concerned, up to the present has not been successfully developed.

By classifying the substances according to the elements they contain and by studying their action with water, alkali, acid, reducing agents, etc., the authors have been able to separate the substances generally met with into groups which in turn are subdivisions of classes. Having reached this point, the exact division to which the substance belongs can be determined by specific tests. Detailed methods are given for testing for the different classes of compounds, and a table of many of the more important substances with their physical and chemical properties serves as a valuable and handy reference. While this scheme of analysis may seem very crude as compared with the one we use in organic chemistry, it is a step in the right direction and worthy of careful study and testing.

The second of these books has the same object in view, but is on a less systematic and comprehensive scale. The general reactions seem too few and indefinite and the special reactions not specific enough to enable one to identify organic compounds by its aid unless considerable reference is made to other records.

Contemporary Chemistry. A Survey of the Present State, Methods and Tendencies of Chemical Science. By E. E. Fournier d'Albe, B.Sc.; A.R.C.S.; M.R.I.A., author of "The Electron Theory, etc." New York, D. Van Nostrand Co. $1.25 net.

The author has written a very interesting "birds-eye view of the whole field of modern chemistry." While not intended as a history of chemistry, all the recent discoveries of importance have been included and their importance and relations to other phenomena have been pointed out. One who has worked in some other science than chemistry, as well as students of this subject, will find this book instructive and well worth reading.

Progressive Problems in General Chemistry. By Charles Baskerville, Ph.D., Professor of Chemistry, and W. L. Estabrooke, Ph.D., Instructor in Chemistry, College of the City of New York. Heath & Co. 1910.

The authors have brought together a large number of problems covering all the phases of chemical action. This book will furnish the teacher a mine of material from which he may select examples to meet the needs of the students as the different subjects are studied and so test their understanding of the principles involved. The solution of problems, such as these, is of special value in the early stages of the study of chemistry and especially with young students, as it demands the power of applying the facts and reasoning from them and not simply the ability to commit facts and reactions to memory. The value of this work might be increased by adding at the beginning of each subject a general statement as to the methods of solving the problems in this section and the principles involved for the aid of those who are not sufficiently familiar with the subject to work it out entirely independently.

J. E. Gilpin

The Johns Hopkins University

Bibliography of Non-Euclidean Geometry, including the Theory of Parallels, the Foundations of Geometry, and Space of n Dimensions. By Duncan M. Y. Sommerville. London, Harrison and Sons. 1911. 8vo. Pp. xii + 403.

In these days, when a non-Newtonian mechanics, based on the principle of relativity, is forcing itself upon the attention of the scientific world, it is instructive to notice how valuable the non-Euclidean and *n*-dimensional

geometries have become, although it is only about forty years since they began to be appreciated thoroughly and studied systematically. The vast and increasing interest which these subjects have aroused is indicated by the fact that Sommerville's Bibliography contains the titles of about 2,300 works on non-Euclidean geometry, of which nearly 800 were published in the decade 1901–10, and 1,800 works on hyperspace, of which 700 belong to the same decade. Let us glance briefly at a few of the principal ways in which these sciences have shown themselves to be of importance, not only in mathematics, but also in the related domains of mechanics, logic, psychology and epistemology.

In the first place, a flood of light has been thrown on the epistemological problem of the nature of our spatial concepts. Kant's famous doctrine of the *a priori* synthetic nature of these concepts is seriously threatened by the modern geometry, and will require considerable modification, if it is not entirely rejected.

In the realm of psychology, also, these theories have a decided bearing on the distinction between the perceptual space of experience and observation and the conceptual idealized space of mathematics proper. The former space has a physiological basis, principally visual and tactual, and the theorems of its geometry can have only an approximate meaning. Now the striking fact is that this natural geometry of experience is much more nearly non-Euclidean than Euclidean. For instance, as Mach observes, the space of tactual perception, namely, the skin, corresponds roughly to a two-dimensional Riemannian space. Moreover, with all the refinements of astronomical observation the space of visual perception can obviously never be proved to be Euclidean.

The recent developments of deductive logic as typified by the symbolic logic of Peano and Bertrand Russell unquestionably owe much to non-Euclidean geometry; and they in turn have helped to make the foundations of geometry secure at last, after two thousand years of misplaced confidence in Euclid.

In the domain of mechanics, if in addition to the three Cartesian coordinates of a moving particle we interpret the time as a fourth coordinate, we obtain a space of four dimensions, and thus establish a useful correspondence between three-dimensional kinetics and four-dimensional geometry. Now the remarkable thing about this correspondence is that whether the original kinetics is Newtonian or non-Newtonian, the corresponding geometry is in each case of a non-Euclidean type.

Perhaps the highest significance, however, of these seemingly pathological theories is due to the light which they shed on other, less suspicious branches of mathematics. For instance, the geometry of hyperspace provides a convenient language in which to express the theory of functions of several variables; and in particular the projective geometry of n-space is closely connected with the algebra of forms, or quantics, involving $n+1$ variables. Moreover, the point-geometry of 4-space helps us to understand the sphere-geometry of ordinary 3-space, because the spheres of 3-space form a four-dimensional aggregate.

Non-Euclidean geometry, also, derives its chief importance from its bearing on Euclidean geometry. It often discloses unsuspected bonds of relation between apparently disconnected Euclidean developments. It brings out the inner meaning of the process of building metric geometry on the basis of projective geometry. It gives a clear insight into the theory of surfaces of constant curvature. Of great value is the correspondence between the group of projective transformations which leave a quadric surface invariant and the group of non-Euclidean movements. Another correspondence of similar importance is that which exists between the group of conformal point-transformations of a Euclidean 3-space and the group of movements of a non-Euclidean 4-space.

Sommerville's Bibliography consists of three parts, a chronological catalogue, a subject index, and an author index. In the chronological catalogue the titles of the works published in each year are arranged alphabetically according to the authors. Later editions, translations and reviews are included.

In the subject index no titles are given, but references are given to the year and author, so that the corresponding title can be easily found in the chronological catalogue.

It is obvious that a scientific bibliography like this serves a very useful purpose to the student and investigator, especially when it is well arranged and possesses a high degree of completeness, as is the case here. With Sommerville's book at his command the worker in the field of non-Euclidean or *n*-dimensional geometry is unusually well equipped for referring quickly to the literature of his subject.

ARTHUR RANUM

CORNELL UNIVERSITY

Report on the Dune-Areas of New Zealand, their Geology, Botany and Reclamation. By L. COCKAYNE, Ph.D., F.L.S., Department of Lands, New Zealand. Printed by John Mackay, government printer. 1911.

Because of extensive dune-areas and the impending danger to valuable lands from encroachment, the Dominion government commissioned Dr. Cockayne to conduct a careful investigation of the dune conditions in New Zealand and to embody certain recommendations as to the reclamation of the dune lands and the protection of threatened territory in a formal report. This report, which is an extension of the author's earlier researches, we now have from the government printer. The paper is divided into two parts; the first deals with the geology and botany of the dune-areas and the second with various methods of reclamation. In Part I. the geology of these dynamic habitats is very excellently handled under such subheads as: The Material of Dunes, Dune Building on the Coast, The Effect of Solid, Flexible and Inflexible Obstacles, and the Effect of Climate, General Topography of the Dune-areas in New Zealand, Movements of Dunes and Dune-sand. There are more than 300,000 acres of dune lands in North and South Islands, where occur chains of sandhills of irregular form, which are generally divided in places by basin-like hollows of greater or less extent. The wind plays a great part in constantly changing the form of the dunes, the position of the hills, and in modifying the slope angles. Hills in all stages of growth and decay, and basins in the process of being hollowed out or being filled up appear on every side. The wider dune areas appear like seas of sand with the ridges as more or less stationary billows with their scanty vegetation.

Under "Botany" is treated such ecological matters as: Climatic Factors, Heat, Light, Moisture, Soil, Topography and Biotic Factors. The most characteristic plants with their growth-forms and adaptations are treated in considerable detail. The leading dune plants in New Zealand are: *Spinifex hirsutus* (Gramineæ); *Scirpus frondosus* (Cyperaceæ); *Euphorbia glauca* (Euphorbiaceæ); *Carex pumila* (Cyperaceæ); *Calystegia Soldanella* (Convolvulaceæ); and *Arundo conspicua* (Gramineæ). These plants are distinguished as "sand-binders" in distinction to the following which are called "sand-collectors": *Caprosoma acerosa* (Rubiaceæ); *Pimelea arenaria* (Thymelæaceæ); *Cassinia leptophylla, C. fulvida, C. retorta* (Compositæ); *Festuca littoralis* (Gramineæ); *Calamagrostis Billardieri* (Gramineæ); and *Scirpus nodosus* (Cyperaceæ).

The commoner plant associations represented are: Sand-Grass Dunes, Pes Capræ Dunes, Shrub Dunes, Lakes and Swamps, Dry Hollows and Stony Plain. The various dune species are noted in tabular form with various ecological notes. This list includes 147 species of which 82 are endemic, 43 Australian and 15 South American. Fifty-one families and 104 genera are represented in this number.

The methods in vogue the world over for the artificial fixation of dunes are based upon those which nature herself uses and these are here enumerated as fifteen "fundamental principles" with which plant ecologists are more or less familiar. Marram-Grass, *Ammophila arenaria,* and the Tree-Lupin, *Lupinus arboreus,* are noted as the best of the "sand fixers" for the region under consideration. The efficiency of these two species is compared in considerable detail. Under "Methods of Reclamation" the methods of preparing and

planting Marram-Grass and Tree-Lupin are discussed in detail and suggestions are included for the post-planting management of the plantations. The possibility of checking sand movement by means of sand-fences and protection belts is considerably elaborated. Protection belts are merely narrow bands of Marram set at the junction of the advancing sand and the invaded ground. Such a belt is efficient usually for only a few years unless it is constantly watched and repaired.

The report closes with a discussion of afforestation of the dunes, which method seems to the author to be the only means of establishing the desired static condition over the dune complex. Little tree-planting upon the dunes has been done in New Zealand under difficult conditions, but the method is strongly recommended. The more important trees and shrubs for dune afforestation in these islands are as follows: *Olearia Traversii, Pinus pinaster, Pinus halpensis, Araucaria excelsa, Cupressus macrocarpa, Pinus radiata* (most valuable), *Pinus muricata, Tamarix gallica, Lupinus arboreus, Acacia melanoxylon, Salix caspica, Populus deltoides, Populus balsamifera, Populus fastigiata* and *Alnus glutinosa.* Besides these species, all of them promising dune holders, *Pinus laricio, P. pinea, P. Coulteri* and *P. Strobus* grow "quite well" on the dunes of New Zealand. A final list of plants (over 200 species) suitable for dune cultivation in these islands contains useful information as to the habitat, growth-form, etc., for the various species, many of which are North American.

This very interesting and well-written paper is well illustrated by means of sixty-nine half-tones and three etchings, and includes a bibliography of sixty-six general works and seventy-three references to the literature of New Zealand Dunes.

RAYMOND J. POOL
THE UNIVERSITY OF NEBRASKA

Aerial Navigation. A Popular Treatise on the Growth of Air Craft and on Aeronautical Meteorology. By ALBERT F. ZAHM. New York, D. Appleton & Co. 1911. 8vo. Pp. xvii + 497; 58 illustrations in text and 32 full page plates.

Amid the flood of ephemeral popular and pseudo-scientific books on this subject which have appeared in England and America during the past two years, here is one that rests on a solid foundation, fit to carry the superstructure of subsequent progress. The author, distinguished as a pioneer investigator of aerodynamics in America, has been intimately acquainted with Langley, Chanute and the Wrights, and a close student of aeronautics in Europe. Therefore Dr. Zahm is eminently qualified to write a book, which in character resembles the reviewer's earlier and smaller "Conquest of the Air," a revised edition of which Dr. Zahm's later and more detailed publication seems to render superfluous. However, the most recent achievements in aeronautics chronicled in any book are already antiquated and surpassed when presented to the reader and conclusions based thereon require corresponding modification.

Authors naturally give prominence to those subjects with which they are most familiar and, therefore, while the reviewer accorded first place to the Ocean of Air, Dr. Zahm puts Aeronautical Meteorology last, having compiled this section largely from other authors and thereby somewhat neglected its status in this country. The two preceding divisions of the book are: the Growth of Aerostation, in which both spherical and dirigible balloons are considered, and the Growth of Aviation, treating of early attempts to fly, the modern glider and the power aeroplane. An appendix contains technical papers and three letters of Benjamin Franklin, written from Paris in 1783 describing the first balloons, which are reprinted from "The Conquest of the Air." The author refrains from prophecies concerning future developments of craft either lighter or heavier than air, since progress in the art of aerial navigation has been so rapid as to baffle conjecture concerning their ultimate applications.

In conclusion, it may be said that the work can be recommended, to either the lay or scientific reader, as admirable in its material

and method of presentation. The numerous illustrations are wisely chosen and well rendered and the few errors noticed in the text are mostly typographical. A misleading misprint occurs in the statement that the first successful dirigible balloon in 1885 sailed from Calais to Paris and returned to its place of departure, which really was Chalais-Meudon, a suburb of Paris.

A. Lawrence Rotch[1]

Blue Hill Meteorological Observatory

SPECIAL ARTICLES

HEATING OF LOCAL AREAS OF GROUND IN CULEBRA CUT, CANAL ZONE[2]

The marl shales, through which Culebra Cut extends, in the region opposite the Culebra railway station, have, from time to time, on exposure to the atmosphere, become hot. The intensity of this heat has varied from noticeably warm to a temperature sufficient to readily char wood, without, however, causing it to burst into a flame. The duration of this heating has been from a few days to several weeks. These shales are dark, thin bedded, soft and easily crumbled, and some of the layers are largely fine basic tuff, loosely cemented by lime. Other beds contain more carbonaceous material, with some local partings of lignite an inch to a foot or more thick. The relatively unweathered character of these basic sediments is evidence that they were derived from nearby volcanic mountains, and the carbonaceous and lignitic layers in them indicate shallow water and swamp conditions of deposition. The presence of fossil oysters, pelecypods, corals and foraminifera show that these shallow estuaries were marine, and that they existed in early Tertiary time. Dr. T. Wayland Vaughn, of the U. S. Geological Survey, examined some of the specimens on the ground and gave it as his opinion that they are Oligocene in age. The evidence so far points to a shallow water connection between the Atlantic and the Pacific during Oligocene time.

After exposure to the atmosphere by drilling, or blasting, certain local areas of this formation become, in the course of a few days, warmed up, and as the heating goes on the carbonaceous matter in the shales is gradually oxidized off and they tend to assume a gray to dull reddish color. The first working hypothesis entertained in looking toward a solution of this heating phenomenon was that possibly the heavy blasting had furnished heat enough to break down the calcium carbonate present to the oxide form, and that ground water and atmospheric moisture reacted on this to slake it and thus probably generate sufficient heat to start the oxidation of the carbonaceous material. This hypothesis was, however, rendered untenable by three lines of evidence:

1. The heating was much more local than the calcium carbonate, and the carbonaceous matter.

2. The heating bore no definite relation to the lime and carbon content of particular beds.

3. Colonel Gaillard, in charge of the Division, informs me that in some instances the heat began in the holes some time after they had been drilled, but before the ground had been blasted at all.

Another line of inquiry was suggested by finding a small amount of pyrite in some of the beds which were heating. It was suspected that this, through its oxidation, was a factor in furnishing the initial heat of the action. In April, 1911, samples of the beds then heating were sent to the chemical laboratory of the U. S. Geological Survey with instructions to make qualitative tests for sulphur and other products that might serve, through oxidation, as the mainspring of the action. These tests revealed the presence of sulphuric acid to the amount of 1.92 per cent., also minute crystals of gypsum. This confirmed the hypothesis that pointed to the pyrite present as the substance acted on by atmospheric oxygen to develop the initial heat.

The most aggravated case of heating so far noted is now going on in Culebra Cut, about 350 yards north of the foot of the stair at the observation tower near Culebra Station. The

[1] This review was written immediately before the lamented death of Professor Rotch.—Ed.

[2] Published by permission of the chairman of the Isthmian Canal Commission.

mass of heated ground here is about 500 feet long by 20 feet wide, and the action reaches a depth of perhaps 15 or 20 feet. Blue smoke, which contains a high percentage of sulphur-dioxide, issues from vents in the mass, and fragments of wood inserted in these are readily charred and consumed. A small amount of steam may also be detected emanating from local moist spots, but this is mainly due to the vaporization of ground water. In the investigation of this heated mass samples were taken, and these were tested qualitatively for sulphuric acid and for sulphates of calcium, aluminium and magnesium. The tests were made by Mr. Jacobs, of the Hospital Laboratory Staff at Ancon, and they revealed the presence of all of the above substances, both in the shale and as the white coating on the moist spots and steam vents of the mass. The yellow deposit near the larger vents is sulphur. Sulphuric acid, especially, was shown to be present in considerable quantity. The origin of the sulphuric acid here was at first a puzzle, because the examination of many samples, with the naked eye and with the microscope, failed to reveal the presence of pyrite. Finally samples of eight to ten pounds were taken, ground with water in a large mortar for some minutes, and then concentrated to a few ounces by washing or "panning." This concentrate showed a high content of pyrite, much of which could scarcely be seen with the naked eye. Under the microscope very small crystals of pyrite were noted; also considerable magnetite, present as black sand, and some sub-angular to fairly rounded grains of quartz.

The mainspring of the action here then, as in the other instances observed, has undoubtedly been the oxidation of the pyrite. The reasons why this oxidation has been so rapid and effective, seems to be as follows:

(*a*) The finely divided, almost microscopic, character of the pyrite gives maximum surface exposure to atmospheric agencies and greatly promotes oxidation.

(*b*) The very warm, moist atmosphere. The tropical sun shining directly on dark rock surfaces produces a temperature sufficiently high to greatly promote oxidation, especially in the presence of slight moisture.

(*c*) Once oxidation of the pyrite has been started the heat thus generated tends to accelerate chemical action and thus the heating increases in geometric progression.

(*d*) When the heat of pyrite oxidation reaches the comparatively low temperature of oxidation of the hydrocarbons present in the lignitic shale, they, too, become oxidized and still further add to the temperature. Finally the fixed carbon content tends to become oxidized, at least in part, and gives maximum intensity to the action.

(*e*) Some heat is also generated by the action of the free sulphuric acid on the calcium carbonate for the formation of gypsum. Other minor chemical actions added their quota to the total heat.

As the temperature rises all chemical activity is vastly stimulated and the heating increases to a maximum. After the most readily oxidizable substances are consumed the heat gradually dies down toward normal temperatures, which may be reached in a few weeks or months. The intensity and duration of the heat depends largely upon the percentage of finely divided pyrite, volatile matter and fixed carbon in the rocks.

Some of the geological considerations suggested by a study of this phenomenon are:

(*a*) Chemico-thermal springs. Whenever jointing fissuring or change of groundwater level gives free access of oxygen-bearing surface waters to beds which contain the necessary finely divided pyrite, and carbonaceous matter, a heating up of such beds is likely to result. Groundwater flowing over such heated beds, and coming to the surface in the general vicinity of them, would constitute thermal springs.

(*b*) Should a rise of land surface bring pyrite-bearing beds from subaqueous to terrestrial conditions, oxidation of the pyrite might, in the course of a year, give local redbeds that would otherwise require centuries of atmospheric action to produce. Of course it is recognized that no very extensive redbeds could be produced in this way.

(c) The very fine pyrite sparingly disseminated through the carbonaceous shales, herein described, seems to have resulted from the action of sulphur, from decaying animal and vegetable life, on the ferro-megnesian silicate fragments which are abundant in these sediments.

DONALD F. MACDONALD,
Commission Geologist

CULEBRA, C. Z.,
April 1, 1912

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

WASHINGTON MEETING, DECEMBER, 1911

THE thirteenth session of this society was held at the Carnegie Institution in Washington, D. C., on December 27–29, 1911, with President E. C. Pickering in the chair. There were sixty-four members of the society in attendance besides many friends. Nine persons were elected to membership, making a total of more than 270 members.

Six sessions were held, two of which were joint meetings with Section A of the American Association for the Advancement of Science. At the joint sessions Professor E. B. Frost presided in the double capacity of vice-president of Section A and first vice-president of the Astronomical and Astrophysical Society of America; and for these sessions a special program was arranged comprising addresses by Professor Lewis Boss on "Recent Researches as to the Systematic Motions of the Stars," by Professor E. H. Moore, retiring vice-president of Section A, on "The Foundations of the Theory of Linear Integral Equations" and by the Reverend Joel H. Metcalf on "The Asteroid Problem."

The society's scientific program included thirty-two papers and also reports from the committees on comets, photographic astrometry and cooperation in the teaching of astronomy. A new committee on asteroids was created with members, E. W. Brown (chairman), J. H. Metcalf, G. H. Peters and A. O. Leuschner.

The following members were in attendance at the Washington meeting: Misses L. B. Allen, H. W. Bigelow, A. J. Cannon, M. M. Hopkins, E. A. Lamson, Mary Proctor, S. F. Whiting, Messrs. A. T. G. Apple, E. E. Barnard, S. G. Barton, L. A. Bauer, L. Boss, J. A. Brashear, E. W. Brown, C. A. Chant, H. S. Davis, C. L. Doolittle, E. Doolittle, R. S. Dugan, J. C. Duncan, J. R. Eastman, W. S. Eichelberger, F. E. Fowle, E. Frisby, E. B. Frost, C. H. Gingrich, A. Hall, W. M. Hamilton, J. C. Hammond, H. B. Hedrick, G. A. Hill, W. J. Humphreys, H. Jacoby, H. H. Kimball, W. F. King, F. B. Littell, F. H. Loud, E. O. Lovett, C. A. R. Lundin, Jr., J. H. Metcalf, W. I. Milham, J. A. Miller, S. A. Mitchell, W. M. Mitchell, H. R. Morgan, C. P. Olivier, G. H. Peters, E. C. Pickering, J. S. Plaskett, R. W. Prentiss, W. F. Rigge, F. E. Ross, A. L. Rotch, H. N. Russell, F. Schlesinger, A. N. Skinner, H. T. Stetson, O. Stone, E. D. Tillyer, A. B. Turner, F. D. Urie, R. W. Willson, D. T. Wilson, R. S. Woodward.

New members were elected as follows: John August Anderson, Johns Hopkins University, Baltimore, Md.; Zaccheus Daniel, Allegheny Observatory, Pittsburgh, Pa.; Walter M. Hamilton, 2307 Washington Circle, Washington, D. C.; H. H. Kimball, Weather Bureau, Washington, D. C.; William Francis Rigge, Creighton University; Harlow Shapley, The Observatory, Princeton, N. J.; Vesto Melvin Slipher, Flagstaff, Ariz.; Albert Harris Wilson, Haverford, Pa.; Charles Clayton Wylie, Laws Observatory, Columbia, Mo.

The program of the meeting included the following papers and reports:

A Device for Facilitating Various Forms of Computation: E. W. BROWN.

The device consists of a frame and a carrier which supports a number of tapes. On these tapes small oblong pieces of cardboard are pasted, the members to be summed being written on the pieces of cardboard. It is essentially a device for avoiding the frequent rewriting of the same number when it has to enter into a calculation in many different ways. It is being used for the summation of many small harmonic terms at numerous time-intervals and for the formation of double-entry tables which consist of ten or more terms of the type $A \cos (i\theta + j\phi + \alpha)$ where i, j are integers, α, A constants and θ, ϕ increase uniformly with the time. It will probably be also used for the analysis of numerous observations at equal time-intervals into harmonic terms whose periods are known or have been previously determined, as, for example, in obtaining the tidal constants of a port from hourly observations of the tide height.

The Lesson of Joseph Piazzi's Life: H. S. DAVIS.

Piazzi's career is followed from his birth, through

his student days in Milan, Turin and Rome, and his professional days in the universities of Genoa, Malta, Ravenna, Cremona and Rome, and while getting wider experience in Paris and Greenwich preparatory to beginning his long period of astronomical observations at Palermo, where he built an observatory on the royal palace.

The method of his observing for the large catalogue of stars, his discoveries of certain stellar proper motions, his wide range of observations and of writings on astronomical and geodetic subjects, are narrated to elucidate the influence which this Theatine priest exerted on the science of his and later days, and inversely to exemplify the influence which had been exerted on him by his environment and by his intercourse with Laplace, Lagrange, Delambre, Bailly, Cassini, Herschel, Wollaston, Oriani, Cagnoli and other notable men of astronomy. It is further shown how his discovery of Ceres was not altogether an accident, nor by any means his greatest achievement, but was the natural by-product of his plan of work and his persistent diligence; and that all the many and valuable fruits of his quarter-century of labor were but the outgrowth of an unselfish devotion that had adopted as its motto the words of Seneca: "At mehercules non aliud quis aut magnificentius quaesierit aut didicerit utilius, quam de stellarum siderumque natura."

(This paper will be published *in extenso* in "Makers of Astronomy," soon to be issued by the Fordham University Press, New York, as companion to "Makers of Electricity.")

The Astronomischer Jahresbericht (an Announcement): H. S. DAVIS.

A brief historical summary of the founding and maintaining of this review of astronomical publications, its plan and scope, and to what extent its purpose has been attained. Its future, since assumption of the editorship by Professor Dr. Fritz Cohn, on the retirement of Dr. Berberich, who succeeded to the editorship on the death of Professor Dr. Wislicenus, its founder.

The Variability of Polaris: JOEL STEBBINS.

The variation in the light of Polaris was detected by Hertzsprung and confirmed by King. Assuming the spectroscopic period of 3.9681 days, Hertzsprung found the light-curve to be approximately a sine-curve with double amplitude 0.17 mag., and King found a similar curve with variation greater than 0.10 mag. Both of these results were from photographs. Observations by the writer with the selenium photometer give a similar curve of the same phase, but of much smaller amplitude, the approximate range being 0.057 mag. It is highly probable that the amount of the visual variation is likewise about 0.06 mag.

The Asteroid Problem: JOEL H. METCALF.

In ninety years from January 1, 1801, to 1891, 323 asteroids were discovered. In the last twenty years about 427 have been added. The rapid multiplication of discoveries and the probable existence of 1,500 brighter than the 14th magnitude demands greater cooperation and division of labor in this field. Except for special investigations the work should be photographic, which gives great facility for observation of old asteroids as well as the discovery of new ones. The importance of the investigation in the light of the discovery of Eros and the Jupiter group of asteroids and the probable existence of still more interesting bodies is increasingly obvious.

Magnitudes, Colors and Spectra of Standard Stars within 17° of the North Pole: J. A. PARKHURST.

This paper describes the determination of the "visual" and photographic magnitudes, color-indices and spectral classes of all the stars down to the B. D. 7.5 magnitude, from declination + 73° to the north pole. There are 666 stars within these limits. The instrument used was a camera having a Zeiss doublet of "ultra-violet" glass, also a 15° prism of the same material. The aperture of each is 145 mm. and the focal length of the lens 814 mm.

The photographic magnitudes were taken from Seed plates exposed 6.5 mm. inside the focus, and the opacity of the images was measured with a Hartmann "mikrophotometer." To obtain the "visual" magnitudes images were taken in focus on Cramer trichromatic plates through a "visual luminosity" filter, and the diameters of the images measured under the microscope. The spectral classes were estimated on the Harvard system from the objective prism plates. The magnitude scale was determined on the "absolute" system, directly by sensitometer squares on the extra-focal plates, and indirectly through the Pleiades stars on the focal plates. The measures were reduced by using the Müller and Kempf Potsdam visual magnitudes of the white stars in each field, and reduced to the Harvard system by subtracting 0.29.

Curves were shown giving comparisons with the results of Schwarzschild, Müller and Kempf and Mrs. Fleming; also the relation between color-index and spectral class, and between the color-index and Müller and Kempf's estimates of color.

A Comparison of Dr. Peters's Celestial Charts with the Photographic Charts of the Sky: J. G. Porter.

The value of star-charts lies, first, in the completeness with which they represent the sky, and secondly, in their availability for use at the telescope.

Four of the photographic charts of the sky, taken at Algiers and Bordeaux, were compared with Dr. Peters's celestial charts, the stars in corresponding regions being carefully counted. In every case the photographic charts contain fewer stars, the percentages running from 51 to 81, and the average being 67 per cent. That is, the visual charts contain on the average 50 per cent. more stars than the photographic charts.

Dr. Peters's charts are pretty complete down to the twelfth magnitude. The photographic charts, therefore, are by no means complete to the twelfth magnitude.

On the photographic charts the images of all but the brighter stars are too faint to see without brilliant illumination, and the configurations of the fainter stars are difficult to trace. Hence these charts are ill suited for use with the telescope.

Two conclusions follow from this comparison. First, the visual charts, so far from being superseded by the photographic charts, are much superior both in their fullness and in their practical usefulness.

Secondly, the photographic charts while ostensibly showing stars to the fourteenth magnitude, really go hardly lower than the eleventh and a half. Some of this discrepancy may be due to the difference between the photographic and visual scales; yet in any case it is clear that in the matter of these charts photography has accomplished far less than was claimed for it, and less than should have been done to justify the expenditure of time and money.

The New Twin Photographical Telescopes of the U. S. Naval Observatory: George H. Peters.

This paper is a continuation of one given at the meeting of the society at the Yerkes Observatory in 1909, entitled, "On the Construction of Astronomical Photographic Objectives at the Naval Observatory." It describes the progress in construction and adjustment of the triple photographic objectives of 10 inches aperture and 110 inches focal length. These new lenses and their mechanical parts, forming a twin photographic telescope, are now practically completed, and are erected in position on the old 26-inch mounting. The tests for errors of adjustment in collimation and refraction are exemplified, together with the methods employed in correcting them.

The Use of Special Topics in Teaching Astronomy: Sarah F. Whiting.

The large numbers who should study elementary astronomy for information and culture should be taught to handle the books of an astronomical library and to express themselves clearly in connected discourse.

To these ends a method more frequently used in literary subjects may well be used—the method of "special topics." A large class for this exercise must be divided into parallel sections; the topics must be given out with bibliography and suggested outline, and the presentation of the topics before the class rated for excellence of outline, form of presentation in language and manner.

Such series of topics as the following have been found practical.

1. Historical topics, some of which may be presented in connection with the biographies of astronomers.

2. A series of topics to show the knowledge of astronomy at different epochs—astronomy of the Bible, astronomy of Homer, astronomy of Milton, astronomy of Shakespeare.

3. The progress of astronomy as related to instruments and mathematical methods. The development of the telescope, of calculus, logarithms, etc.

4. A set of topics to show the immense cost in money and labor to obtain facts—eclipse expeditions, expeditions to obtain solar parallax.

5. Great observatories.

6. Special studies of celestial objects—Halley's comet, net in Orion, etc.

The Orbit of the Spectroscopic Binary, β Scorpii: J. C. Duncan.

The variability of the radial velocity of the brighter visible component of β Scorpii was discovered by Dr. V. M. Slipher at the Lowell Observatory in 1903. In 1908 he found that the star's spectrum showed a sharp, non-shifting K line. The writer of the present paper has determined the orbit of the binary from seventy-nine spectrograms made by Dr. Slipher in 1908, 1909 and 1911.

Measurement of the spectrograms was rendered difficult by the scarcity and diffuseness of the spectral lines. In addition to the K line, two

lines of hydrogen and three of helium were all that could be measured. The H line of calcium is concealed by the broad H of hydrogen. On some of the plates the presence of the fainter component of the binary is made evident by the doubling of the lines of hydrogen and helium, so that on these plates three different velocities are indicated—that of each component of the binary and that of the K line.

The orbital elements derived are as follows:

	Bright Com.	Faint Com.
Period, P	6.8292	
Eccentricity, e ..	0.25	
Time of periastron, T	1908 July 2.98	
Dist. node to periastron, ω	20°	200°
Semi-amplitude of vel. curve, K ..	126 km./sec.	166 km./sec.
Maximum velocity	+150 km./sec.	+120 km./sec.
Minimum velocity	—102 km./sec.	—211 km./sec.
Projected semi-axis major, $a \sin i$ ..	11,457,000 km.	15,094,000 km.
Ratio of masses .	1: 0.91	
Velocity of system	—6.0 km./sec.	
Velocity of calcium	—16.4±0.6 km./sec.	

The velocity of the calcium differs by ten kilometers per second from that of the center of gravity of the binary system—a difference that seems too great to be explained by errors of measurement or of the assumed wave-lengths. Since a uniformly moving mass accompanying the system would be expected to have a velocity equal to that of the common center of gravity of the revolving stars, this investigation may be regarded as tending to support the hypothesis, favored by Slipher and others, of a detached calcium cloud in the line of sight.

There is some indication that the period is slowly lengthening. It is hoped that data derived from some older plates by Dr. Slipher may decide this point. This will also have a bearing on the question of the location of the calcium since, if the star is involved in a cloud of calcium or other substance, the friction should cause the period to shorten.

The Dissolution of Solar Prominences: FREDERICK SLOCUM.

Among the photographs of solar prominences at the Yerkes Observatory there are several series which show prominences in the act of dissolving. In general the prominences dissolve in one of the four following ways:

1. By floating up and dissipating like smoke from a fire.
2. By ascending and contracting into a long, fine filament.
3. By being torn into fragments and borne away as if by a strong wind.
4. By dissolving *in situ* like the trail of a meteor.

These processes were illustrated by lantern slides giving series of views of the prominences of June 19–20, 1911; September 19, 1911; July 25–29, 1908; March 25, 1910, and single views of other prominences.

All of the photographs were taken in the light of the H line of calcium with the Rumford spectroheliograph attached to the 40-inch telescope.

The Parallax of Nova Lacertæ 1910: FREDERICK SLOCUM.

Nova Lacertæ was discovered by Espin December 30, 1910. During the year 1911 ten photographs of the region around the Nova were made with the 40-inch telescope for the purpose of determining the parallax of the star. Cramer instantaneous isoplates were used in connection with a yellow color filter. In general two exposures were made on each plate. The exposure time was increased from 5 to 15 minutes as the star diminished from somewhat brighter than the 8th down to the 12th magnitude. Six comparison stars were selected as symmetrically situated as possible, and as near as possible to the mean brightness of the Nova. The parallactic displacement parallel to the ecliptic was measured. The value of the parallax came out $+0''.013$ with a probable error of $\pm 0''.014$. This would mean that the outburst observed in 1910 really occurred 250 years ago.

A Simple Pyrheliometer: W. J. HUMPHREYS.

This instrument consists essentially of a spherical Dewar bulb filled with mercury and provided with means for absorbing solar energy and measuring its effect.

A hollow platinum cone, polished on the inside, about seven centimeters long and with an opening one centimeter in diameter is symmetrically immersed in the mercury and set so that it will receive sunshine through a suitable system of diaphragms. Such a cone is well nigh a perfect absorber of radiation parallel to its axis, and as constructed the heat absorbed is rapidly transmitted to the mercury, the expansion of which is measured in a thermometer stem.

The readings consist in taking the time interval during the expansion of the mercury up the ther-

mometer stem from one to another fixed point. Provision is made whereby, after one time interval has been obtained, the mercury can be set back below the first mark, and then another interval read, and so on as long as necessary.

The intensity of the insolation is inversely proportional, approximately, to the above time intervals—the times required for delivering substantially equal amounts of heat to the mercury.

While capable of development as a standard it was designed as a secondary instrument, the chief features of which are:

1. Essentially complete absorption of insolation.
2. Unchanging coefficient of absorption.
3. Highest possible heat insulation.
4. Freedom from calibration.
5. Ease of manipulation.

The Violle Actinometer as an Instrument of Precision: F. W. VERY.

The principal objects of this research are to show that the Violle actinometer may be used either dynamically or statically with equal precision, and to develop the theory of its static use.

Hitherto the rates of cooling of a thermometer in a partial vacuum have been used to get an estimate of losses by convection in an actinometer in air, but these measures have not differed essentially from the experiments of Dulong and Petit, and are quite inadequate, since they entirely neglect the losses by penetration of gaseous molecules. It is very commonly assumed that the velocity of cooling in "vacuum," obtained by Dulong and Petit,

$$V = k((1.0077)^{t+\theta} - (1.0077)^{t}),$$

represents a law of *radiation;* but this is not the case, since the observations included both radiation and penetration, and the latter is by no means insignificant.

By the use of Stefan's law for pure radiation, I first separated the radiant component, and from experiments by Langley and myself, and by Kundt and Warburg, I derived a preliminary value of the penetration in C.G.S. units,

$$P = 0.0001397\,\theta.$$

This, however, did not represent the observations so closely as could be wished, and it was evident that dimensions and form of both radiating body and enclosure must enter into a complete theory. Taking Winkelmann's value of K (the constant of penetration for a plane surface in C.G.S. units), calling r the radius of the thermometer-bulb, l the distance to the enclosing surface, and θ the temperature of excess, and reducing to minutes,

$$P = 4K\theta \times \frac{4\pi r^2}{l} \times 60.$$

With this formula the penetration was computed for two thermometers used by Langley on Mount Whitney in a Violle actinometer with the following result:

$\theta = 30°$ C., Green 4,572, cooling per minute by penetration, $-2°.248$; observed, $-2°.08$.

$\theta = 30°$ C., Baudin 8,737, cooling per minute by penetration, $-2°.588$; observed, $-2°.84$.

The convection loss can be represented by the formula

$$C = c \times \theta^{1.233} \times (p/p_1)^{0.45},$$

where

$$c = 0.000,005,02 + \frac{0.000,036,76}{r}\ \text{(C.G.S.)},$$

a value determined by myself. p and p_1 are actual and normal barometric pressures, and the exponents are those of Dulong and Petit. For the given excess and Baudin thermometer,

Loss of temperature per minute by convection $= -4°.158$

Loss of temperature per minute by penetration $= -2°.588$

Loss of temperature per minute by radiation $= -2°.890$

Computed total loss $= -9°.636$

Found $= -9°.2$

The final difference of about 0°.4 includes errors of observation and also stem conduction which in this case was towards the bulb, or positive, the thermometer having been previously heated as a whole.

With some minor emendations relating to the general theory of the instrument, which can not be described here, I obtained from Keeler's observation with the Violle actinometer on the summit of Mt. Whitney:

Solar radiation at noon from initial rate of heating $= 1.995$ cal. per sq. cm. per min.

Solar radiation at noon from static temperature $= 2.001$ cal. per sq. cm. per min.

The difference in the results by the two methods is insignificant.

Improvements are suggested in the mounting and use of the instrument, and certain necessary precautions which have sometimes been neglected are described.

The Revised Draper Catalogue: ANNIE J. CANNON.

Owing to a general desire among astronomers for the class of spectrum of many more stars than have yet been studied, work has been begun upon a new catalogue of stellar spectra, to be called the Revised Draper Catalogue. The whole sky will be covered by photographs taken with a prism placed in front of the object glass of the 8-inch Draper and Bache telescopes, the exposure being generally one hour. It is believed that all stars of the eighth magnitude will be included, as well as many fainter ones. All the classification will be made by the writer, using the notation described in the *Harvard Annals*, volume 56, pages 66 to 69.

This work can be done rapidly, since previous study and classification of more than five thousand spectra taken with the various Harvard telescopes have made each division and subdivision a definite picture in the mind. Three assistants are working daily upon the laborious identifications, the reductions and the clerical part of the catalogue. Seven thousand spectra have already been classified, and it is estimated that if we have equally good photographs for the whole sky, the catalogue will contain one hundred thousand stars. It is proposed to print it in sections in the order of right ascension, of which the portion from 0^h to 6^h will form the first volume.

Notes on the Determination of the Elements of Algol Variables: H. N. RUSSELL.

Further study of this problem on which a report was made to the society in August, 1910, shows that, when there is no constant period at minimum (*i. e.*, when the eclipse is partial), it is possible to represent the observed light curve within the error of ordinary observations by arbitrarily choosing any value within certain limits for the ratio of the radii of the two stars, and then determining the other elements in a suitable manner.

The various sets of elements, however, give different depths for the secondary minimum; and if this has been observed the problem becomes determinate, unless the primary and secondary minima are of nearly equal depth. In the latter case additional data (which can sometimes be supplied by spectrographic observation) are necessary if the elements are to be definitely determined.

Tables have been prepared which facilitate the numerical solution of these problems. With slight modifications, these may also be used in the case of variables of the Beta Lyræ type, in which the two stars are very close, and are distorted into prolate ellipsoids by their mutual attraction.

The Eclipsing Variables W Crucis and W Ursæ Majoris: H. N. RUSSELL.

Good light-curves of these stars have been determined, the first at Harvard by Miss Leavitt, the second at Potsdam by Muller and Kempf and by Baldwin. Both are of the β-Lyræ type, and in each case the observations can be very satisfactorily represented on the eclipse theory.

W Crucis has a period of 198.5 days and a range from $8^m.9$ to $9^m.5$, with a secondary maximum of $9^m.2$. The system consists of two stars, one twice as bright and two and a half times as large as the other. The ratio of the longer and shorter axis of the ellipsoidal stars is 7:6. The relative orbit has an eccentricity of 0.04, and at periastron the surfaces of the two stars are separated by a distance slightly exceeding the diameter of the smaller. At principal maximum the smaller star is totally eclipsed by the larger. Increase and decrease of light lasting 14 days and totality 15 days.

The density of the larger star can not exceed 1/160 that of the smaller star, 1/10 that of the air under ordinary conditions. The spectrum is G pec. with bright lines.

This system is evidently in a very early stage of development, and if comparable with the sun in mass and surface brightness, must be at a distance of many thousand light-years.

The writer is greatly indebted to Professor Pickering and Miss Leavitt for unpublished observations of this star.

W Ursæ Majoris varies from $7^m.9$ to $8^m.5$ in a period of 8 hours, within which there are two equal and equidistant maxima and minima. Its variations may be very satisfactorily represented on the assumption that the system consists of two stars, equal in size and brightness, with longer axes 4/3 of the shorter axes, revolving in a circular orbit, and separated by only 2/5 of their longer diameters. At maximum one star obscures half the disk of the other, the eclipse lasting one and a half hour.

The light-curve may be equally well represented with any ratio of the two radii between unity and 0.57—the surface brightness of the two stars being equal. The mean density of the system is 2.4 times the sun. This star is also of Spectrum G, but must represent a very different stage of evolution from the other.

The Solar Rotation: J. S. PLASKETT.

This paper gives an account of further work on the spectroscopic determination of the solar rota-

tion, a preliminary paper having been given at the last meeting. It includes a discussion of the measures of 110 spectra at seven different latitudes in the region λ 5,500–λ 5,700 and of 24 spectra at the equator in the region λ 4,200–λ 4,300. The value of the rotational velocity at the equator is at

$$\lambda\,5{,}600,\quad v + v_1 = 2.021 \pm .003 \text{ km.}\quad \xi = 14^\circ.35,$$
$$\lambda\,4{,}250,\quad v + v_1 = 2.012 \pm .003 \text{ km.}\quad \xi = 14^\circ.29,$$

where $v + v_1$ is the linear and ξ the daily angular sidereal velocity. The law of equatorial acceleration or polar retardation follows the Faye form, having the following coefficients:

$$\begin{aligned} v + v_1 &= (1.306 + .701 \cos \phi) \cos \phi \\ &= 10^\circ.84 + 3^\circ.51 \cos^2 \phi. \end{aligned}$$

A comparison of ξ for different determinations gives

Sun Spots	Faculæ	Flocculi	Reversing Layer			
			Duner	Halm	Adams 1906–7	Plaskett
14.40	14.62	14.55	14.81	14.53	14.63 1908 14.61	14.35

Whether the smaller value obtained here is due to some systematic error or to a variation in the rate of rotation there is as yet insufficient evidence to determine. It may be pointed out that the Ottawa observations were obtained at sun-spot minimum and the major part of the others more towards maximum.

A comparison of the residuals from lines of different elements in both regions indicates that any systematic deviations found, not greater except in one case than one third the average residual, are due to some personal systematic effect in measurement and not to differences of the rotational velocity in different elements.

The Moon's Mean Parallax: F. E. ROSS.

The following values of the lunar parallax and related quantities are based upon the constants of the geoid obtained in 1909 by the U. S. Coast and Geodetic Survey and upon Hinks's value of the moon's mass.

$$\begin{aligned} P_0 &= 3{,}422''.526 \pm 0''.012, \\ \Delta &= 238{,}857.9 \pm 1.1 \text{ U. S. statute miles}, \\ S &= 1{,}079.93 \pm 1.04 \text{ miles}, \\ D &= 0.6043 \pm .0003. \end{aligned}$$

P_0 is the constant of the sine parallax, Δ the mean distance, S the semi-diameter, and D the density in terms of that of the earth. The correction to Hansen's parallax is

$$\delta H = + 0''.45.$$

Observations on the moon's limb for the determination of the parallax seem to be subject to large systematic errors. The results obtained by Olufsen, Henderson, Breen, Stone and Batterman lead to a value of 304 for the reciprocal of the earth's flattening. This systematic error seems to be largely eliminated in the recent Greenwich-Cape series of observations on the lunar crater Moesting *A*. The value of the reciprocal of the flattening resulting from this series is 294.45. It is likely that considerable further improvement in the results by the observational method would be obtained by the adoption of a photographic method.

The Secular Variations of the Elements of the Orbits of the Four Inner Planets: ERIC DOOLITTLE.

This paper presents the results of a computation extending over upward of sixteen years which had for its object a new determination of the perturbations of the orbits of the inner planets based on the most accurate elements now obtainable. The method employed differed from that of Le Verrier and Newcomb in that it depended upon the evolution of certain integral expressions instead of on the use of infinite series. Every possible device to insure accuracy was employed, the entire computation being duplicated and all known test equations applied. The well-known discrepancies which exist between certain of the variations as derived from theory and their values as determined from observation merely were fully confirmed. The figures expressing the motions of the perihelion of Mercury, the node of Venus, the perihelion of Mars and the eccentricity of Mercury, respectively, are as follows.

Newcomb	New Computation	Observation
+ 109″.76	+ 108″.91	+ 118″.24
— 106″.00	— 106″.00	— 105″.40
+ 148″.80	+ 148″.74	+ 149″.55
+ 4″.24	+ 4″.235	+ 3″.36

The Language of Meteorology: C. F. TALMAN. (Introduced by W. J. Humphreys.)

Scientific language is nowadays a somewhat neglected subject, and contemporary men of science show a reluctance to label their contributions to knowledge.

In meteorology there is need not only of new terms, but of a much more general use of the terms already introduced and adapted to their

purpose. A very large part of the meteorological vocabulary is unfamiliar to meteorologists. This is illustrated by the case of the "isograms." Upwards of eighty of these lines have been given appropriate names; but not a score of these names are in current use.

In no branch of science is the vocabulary more confused than in atmospheric optics; especially in English. One can hardly write of any but the commonest photometers without defining almost every term one uses. Thus the words "glory," "corona," "aureole" and "anthelion" are variously applied and interchanged; the Brocken specter is confused with the Brocken bow; etc.

Among meteorological neologisms the term "aerology," meaning the branch of science concerned with free-air investigations, deserves a wider use; "stratosphere" is the best name for the region of the atmosphere now more generally called the "isothermal layer"; Arctowski's terms "pleion" and "antipleion" are useful additions to the vocabulary; Dr. H. R. Mill's discrimination of "mean," "average" and "general" will obviate the confusion that heretofore reigned in the use of these words; the application now given in Great Britain to the terms "rime" and "glazed frost" is commended to general attention; L. Besson's name "nephometer" seems appropriate for an instrument used to measure the amount of cloudiness; the derivatives of the new German names for the snow-gauge ("chionometer," "nivometer") are likely to come into general use (*i. e.*, we shall use "nivometric," etc., though we may not adopt the noun); Odenbach's "ceraunograph" is a good international name for the thunderstorm-recorder; the American name "kiosk" gives us a tolerable English equivalent for "Wettersaüle."

An international commission on meteorological terminology is an urgent desideratum.

Can Astronomy Derive Benefit from the Dissemination of Esperanto? F. H. Loud.

The paper first pointed out some of the easily verifiable indications of the entrance of Esperanto upon the stage of practical utility in the ordinary relationships of life, and proofs of the increasing popular acquaintance with it, especially in Europe; and then, passing to the consideration of its possible utilization in the service of astronomy, suggested its employment (1) in the oral discussions and the reports of international conventions, (2) in astronomical treatises, where, in the field of pure mathematics, for instance, such an example has already been set as the work of Dr. Cyril Vörös, of Budapest, on "Absolute Geometry"—a book (including its three sections) of 439 pages, and of high scientific value, and (3) in the dissemination of astronomical news, through the *Internacia Science Asocio* and other channels, where, though the direct service were rather to the general public than to professional astronomers, yet the science would ultimately receive benefit.

On the Flexure of a Meridian Circle: W. S. Eichelberger and H. R. Morgan.

From 1903 to 1911 the flexure of the 9-inch transit circle of the Naval Observatory was determined from measures on collimators. The circle was shifted for each of the six clamp years, and at the end of the work, and the circle flexure distinguished from the tube flexure.

The table gives the division of the circle at the object glass end, the means of the measures on the collimators for each position, and the residuals from the solution of the fourteen equations.

The first eight equations result from 70 sets of measures on the horizontal collimators, and the last six from 68 sets of measures on the vertical collimator and nadir.

Equation	O	Wt	$O-C$
$x_s + y\cos(A - 270°\ 4') =$	$-0''.95$	3	$+0''.11$
$x_s + y\cos(A - 269°\ 56') =$	$-1''.14$	6	$-0''.08$
$x_s + y\cos(A - 264°\ 52') =$	$-1''.02$	6	$-0''.04$
$x_s + y\cos(A - 259°\ 40') =$	$-0''.74$	13	$+0''.16$
$x_s + y\cos(A - 256°\ 28') =$	$-0''.99$	18	$-0''.15$
$x_s + y\cos(A - 261°\ 34') =$	$-0''.89$	6	$+0''.04$
$x_s + y\cos(A - 261°\ 16') =$	$-0''.85$	9	$+0''.07$
$x_s + y\cos(A - 81°\ 16') =$	$+0''.35$	9	$0''.00$
$x_c - y\sin(A - 264°\ 52') =$	$+1''.08$	10	$+0''.12$
$x_c - y\sin(A - 259°\ 40') =$	$+0''.85$	14	$+0''.17$
$x_c - y\sin(A - 256°\ 28') =$	$+1''.13$	12	$+0''.08$
$x_c - y\sin(A - 261°\ 34') =$	$+1''.07$	14	$+0''.07$
$x_c - y\sin(A - 261°\ 16') =$	$+0''.93$	9	$+0''.07$
$x_c - y\sin(A - 81°\ 16') =$	$-0''.96$	9	$-0''.03$

The solution gave: the coefficient of the sine flexure of the tube, $x_s = -0''.289$; the coefficient of the cosine flexure of the tube, $x_c = +0''.037$; the coefficient of the flexure of the circle, $y = +1''.156$; the point of maximum weight of the circle, $A = 137°\ 55'$. To test the sine law, 264 direct and reflected star observations were taken, on both clamps, and both sides of the zenith. The solutions in the table give the error of the nadir, or cosine flexure; a term for bisection error, or other discontinuity at the zenith; and the sine flexure.

Cla'p	No. Nights	$\frac{1}{2}(R-D)$	Mean Residual
E	5	$-0''.71 \pm 0''.34 - 1''.14 \sin z$	$\pm 0''.19$
W	2	$-1''.11 \pm 0''.34 - 1''.11 \sin z$	$\pm 0''.15$
W	4	$-1''.01 \pm 0''.83 - 1''.11 \sin z$	$\pm 0''.15$
W	2	$-1''.60 \pm 0''.40 - 1''.11 \sin z$	$\pm 0''.17$
W	2	$-1''.48 \pm 0''.28 - 0''.58 \sin z$	$\pm 0''.16$
W	2	$-1''.07 \pm 0''.71 - 1''.37 \sin z$	$\pm 0''.18$
E	2	$-0''.81 \pm 0''.22 - 0''.77 \sin z$	$\pm 0''.28$

The agreement with the collimator measures is satisfactory. To test the cosine law, 20,000 star observations, corrected for division error, bisection error, variation of latitude and flexure, were differenced for successive clamp years. The mean values of $(S_w - S_e)$ are:

$-0''.24,\ -0''.23,\ -0''.23,\ -0''.03,\ -0''.11.$

The residuals from these means were solved in the form

$$0''.04 \cos z - 0''.11 \cos 2z.$$

This reduced the mean residual from 0''.09 to 0''.08, only, and has not been used. The mean differences $(S_w - S_e)$ were attributed to the uncertainty in the various nadir division errors. The corrections, following, were, therefore, applied to the different years; their sum is zero:

$+0''.17, -0''.07, +0''.16, -0''.07, -0''.04, -0''.15.$

Tests with Standard Electric Lamps: E. S. KING.

These tests relate to two lamps, rated for 2-candle power, loaned from the Bureau of Standards at Washington. In comparing these lamps with the Argand Standard, I have included 6 commercial lamps, which were regulated to approximately the same intensity. The results for 8 comparisons, made at intervals of about a day, show great constancy. The average deviation in magnitudes for Lamp No. 1 is $\pm$ 0.035, for Lamp No. 2 $\pm$ 0.031, for the mean of the 6 commercial lamps, $\pm$ 0.030 and for the mean of all the lamps $\pm$ 0.025.

Comparisons with ten different stars were made by the out-of-focus method with the 11-inch Draper telescope on seven different nights. The resulting photographic magnitudes for the lamps at a distance of 1 meter are as follows: Lamp No. 1, 12.02; Lamp No. 2, 12.10; Lamp No. 8, 12.01. From the comparisons with the Argand the results are, Lamp No. 1, 12.05; Lamp No. 2, 12.12; Lamp No. 8, 12.04. These figures indicate that the lamps must be placed at a distance of about a kilometer to have the same photographic brightness as Polaris.

Recent Interviews with Optical Glass Manufacturers of France and Germany: J. A. BRASHEAR.

Some Observations with the 60-inch Reflecting Telescope of the Mt. Wilson Solar Observatory: E. E. BARNARD.

Photographic Observations of Brook's Comet 1911: E. E. BARNARD.

This comet when found by Brooks was a faint object without any tail. A long exposure photograph a few days after its discovery showed only a round diffused object with no signs of a tail. Later the comet developed a tail, and became visible to the naked eye and presented a splendid spectacle in the evening and then in the morning sky. Its naked eye visibility was of long duration, from August to December.

Though it developed a slender tail early in its career it was very disappointing, for photographs made night after night did not show any changes worth mentioning and the comet promised to be of little interest from a photographic standpoint. The photographs on different nights simply repeated themselves. In October, however, there was apparently a complete transformation of its nature and it really became one of the most interesting comets yet photographed. From the previous condition of a steady outflow of matter which marked its appearance until October the tail now presented a very active and remarkable appearance changing from day to day from one complex and beautiful form to another equally remarkable. The photographic activity was also greatly increased, much more, apparently, than its increase of light would account for. The phenomena of Morehouse's comet were duplicated in almost every particular. This change in the nature of Brook's comet did not seem to be due to any special change in its spectrum. Cyanogen did not appear at any time in the spectrum of the tail, though it was present in the head. This compound which was such a striking feature of the spectrum of the tail of Morehouse's comet was supposed to be the cause of the remarkable phenomena of that comet. Its absence from the tail of Brook's comet would seem to show that after all it was not necessarily the cause of the freakish nature of that comet.

Personal Equation Apparatus for Nine-inch Transit Circle, Naval Observatory: F. B. LITTELL.

The new personal equation apparatus recently installed is based on the same principle as that devised by Professor John R. Eastman, U.S.N., but differs entirely in details and secures a much more exact reproduction of the circumstances of actual observation and more extended application.

An artificial star moves alternately east and west across the line of sight at the focus of the

north meridian mark, a small electric motor furnishing the motive power. The speed can be varied to represent that of any star from 0° to 89° of declination. The apparent magnitude of the star may be varied by interposing screens in the line of sight, or by changing the resistance in the electric-light circuit.

This star will be observed by the use of the transit circle, just as an actual star would be observed, the movement of the carriage carrying the star in the meantime causing a similar automatic record to be registered on the chronograph. A complete observation includes the observation of the star during its east and west movement, using a reversing prism at the eyepiece to keep the apparent direction the same. By comparing the observer's record of such an observation with the automatic record, his absolute personal equation can be determined, and by suitable series of observations, the personal equations of various observers dependent on velocity and direction of motion, or magnitudes of stars, and for such objects as the limbs of the sun, moon, etc., may be determined.

At present nearly all star catalogues are more or less affected by such errors. Even if a self-registering right ascension micrometer and a reversing prism are used, by which many errors are greatly reduced, it is still desirable that observers should determine them, and if necessary apply corrections for them.

Measures of the Satellite of Neptune, and of Oberon and Titania, Satellites of Uranus, made at the Naval Observatory, 1908–10: ASAPH HALL.

After the publication, in 1875 and 1885, of the measures made at the Naval Observatory of the satellite of Neptune, Mr. Marth pointed out the curious motions of N and I, which determine the position of the satellite's orbit plane with reference to the equator. It has been explained that these motions might be produced by a flattening of the planet which causes the pole of the plane of the satellite's orbit to describe uniformly a small circle about the pole of the planet.

Therefore, for the purpose of following these motions, the satellite of Neptune has been measured at the Naval Observatory during many oppositions.

For the two oppositions 1908–09 and 1909–10, the following corrections have been obtained to the data of the Connaissance des Temps, which are the elements of H. Struve published in 1894:

1908–09	1909–10
$du=+1°.223\pm0°.190$	$du=+0°.521\pm0°.162$
$dN=+1.341\pm0.383$	$dN=+1.097\pm0.313$
$dI=+0.401\pm0.376$	$dI=-0.277\pm0.294$
$Q=\ 179°.51$	$Q=\ 37°.34$
$e=\ 0.002,71$	$e=\ 0.009,60$
$da=+0''.344\pm0''.056$	$da=+0''.058\pm0''.045$

The corrections to u, N and I are believed to be real. Evidently there is a considerable change of personal equation in the distance pointings, as has been shown already in the measures of several observers.

The measures of Neptune's satellite made some years ago at the Yerkes Observatory by Professor Barnard with the 40-inch refractor, give for the semi-major axis of the orbit at the mean distance of the planet from the sun, 16''.22, instead of 16''.27, which is usually accepted.

On account of the large aperture of the telescope employed, this determination appears to be the most accurate of the visual measures, and least liable to systematic errors.

Various experiments have been made at the Naval Observatory with reference to the elimination of systematic errors, including the use of reversing prisms. However, with the prisms employed, so much light is lost that they can be used only on very good nights.

For Oberon and Titania, satellites of Uranus, the following corrections have been obtained to the elements of the Connaissance des Temps from observations made at the oppositions of 1908, 1909, 1910:

Oberon	Titania
$du=+0°.767\pm0°.207$	$du=+1°.340\pm0°.262$
$dN=-0.077\pm0.360$	$dN=-0.634\pm0.474$
$dI=-0.611\pm0.347$	$dI=-0.730\pm0.412$
$Q=\ 218°.41$	$Q=\ 216°.45$
$e=\ 0.0100$	$e=\ 0.0934$
$da=+0''.167\pm0''.119$	$da=+0''.139\pm0''.090$

From measures secured in 1911 by Mr. Eppes and Mr. Burton, Mr. Eppes has found the following corrections to the data of the Connaissance des Temps:

Oberon	Titania
$du=+0°.735\pm0°.179$	$du=+1°.778\pm0°.159$
$dN=-0.263\pm0.261$	$dN=-0.253\pm0.295$
$dI=+0.221\pm0.235$	$dI=+0.033\pm0.271$
$Q=\ 60°.06$	$Q=\ 285°.02$
$e=\ 0.00214$	$e=\ 0.00180$
$da=+0''.072\pm0''.074$	$da=+0''.208\pm0''.075$

The Paris Conference of October, 1911: W. S. EICHELBERGER.

At the recent conference of the directors of the several national nautical almanacs held in Paris in October, 1911, cooperation among the respective offices was recommended to their several governments. A full account of the work of the conference is contained in the *Astronomische Nachrichten*, No. 4535, for November 12, and in *Nature* for November 30.

Attention was called particularly to three of the resolutions adopted by the conference.

1. The conference strongly recommends that the ephemerides of the stars, that is to say, their correction from mean to apparent place, should be calculated for the upper transit at the meridian of Greenwich.

2. The conference is of the opinion that the adoption of the meridian of Greenwich for all ephemerides should be realized as soon as possible.

3. The ordinary ephemerides of the stars shall be calculated to $0^s.001$ in right ascension so far as 60° of declination and $0''.01$ in declination.

The first two resolutions quoted imply that each office in computing results which are to be furnished the other almanacs will do so for the Greenwich meridian. The question naturally arises with reference to the *American Ephemeris*, for instance:

1. Should the ephemerides for the physical observations of the sun, moon and planets and the ephemerides of the satellites of Mars, Uranus and Neptune which will be computed by the office of the *American Ephemeris* for Greenwich mean noon and in that form furnished to the other almanacs, be printed in our almanac for Greenwich mean noon, or is there sufficient reason to require us to make the necessary additional computations to enable us to publish these data for Washington mean noon as at present?

2. Should the apparent places of the stars which will be furnished to the office of the *American Ephemeris* by the European almanac offices for superior passage over the meridian of Greenwich be published in our almanac for transit at Greenwich or transformed to transit at Washington as at present?

3. Is it to the advantage of astronomers in general to have the apparent places of stars given to $0^s.001$ in R.A. so far as 60° of declination and $0''.01$ in declination?

It is not intended to increase the labor of computing to obtain the additional decimal, but simply to publish the additional decimal which is at present always computed in the various almanac offices. Nor is it intended that this last decimal shall be accurate to within a unit. In fact it may be in error several units. The object in publishing the additional decimal is to permit any one to interpolate to the time of observation, the apparent place as given; to apply the short period terms for whose calculation convenient tables will be provided; and finally to obtain his computed right ascension at the time of observation accurately to the hundredth of a second of time and his declination to the tenth of a second of arc.

It is upon these questions that the Naval Observatory would like to have an expression of opinion from the astronomers of the country.

The Spectrum and Orbit of β Scorpii: Z. DANIEL and F. SCHLESINGER.

This is one of the spectroscopic binaries (discovered by Slipher at the Lowell Observatory) for which the H and K lines, due to calcium, appear to be nearly or quite stationary. Only two of these objects have thus far been studied: δ-Orionis by Hartmann and o-Persei by Jordan. From 73 spectrograms secured in 1911 with the Mellon spectrograph of the Allegheny Observatory, the following elements have been derived by means of a least-squares solution.

$$
\begin{aligned}
P &= 6.8283 \text{ days} \pm 0.0001 \text{ day},\\
K &= 125.66 \text{ km.} \pm 1.18 \text{ km.},\\
e &= 0.270 \pm 0.008,\\
T &= \text{J.D. } 2419163.923 \text{ G.M.T.} \pm 0.034 \text{ day},\\
\omega &= +20^\circ.1 \pm 2^\circ.2,\\
\gamma &= -11.0 \text{ km.}
\end{aligned}
$$

Measurements of the secondary spectrum could also be made on some plates, and these yield

$$
\begin{aligned}
K_s &= 197 \text{ km.} \pm 10.5 \text{ km.},\\
m \cdot \sin^3 i &= 13.0,\\
m_s \cdot \sin^3 i &= 8.3,
\end{aligned}
$$

the unit of mass being that of the sun. Using Rowland's wave-length for the K-line, the mean velocity derived from it is -8.6 km. $\pm$ 1.7 km., which is not far from that of the center of mass of the system, a result in accord with those for δ Orionis and o Persei.

Report of the Committee on Comets, December, 1911: G. C. COMSTOCK (chairman).

Owing to the absence of its chairman abroad during a major portion of the past year the work of the committee on comets has consisted mainly

in the accumulation and tabulation of replies to its circular letter relative to photographs of Halley's comet. From these replies there has been constructed a card catalogue exhibiting in chronological order the material available for a photographic history of this comet during its appearance of 1910. At present this catalogue consists of about a thousand titles, but it can not be regarded as complete, owing to the absence of reports from several important sources.

Correspondence is being conducted in the endeavor to supply as far as may be the missing data, but it is already apparent that the existing gaps can not be completely filled. A period of very great activity in photographing the comet accompanies the date of its nearest approach to the earth, but this is preceded by an epoch of comparative neglect and is followed, in July, 1910, by an apparently complete cessation of photographic work upon the comet, continuing until December, when some exposures were made at the Lick Observatory and reported to the committee. It is earnestly hoped that these lacunæ will be filled by observations not yet reported to the committee.

As soon as the card catalogue can be regarded as reasonably complete it is the purpose of your committee to select from it such data for reproduction as will best serve its purpose of constructing a graphic history of the comet's appearance in the years 1909–10.

Report of the Committee on Photographic Astrometry: F. Schlesinger (chairman).

The chairman reported briefly on the progress made since the meeting at Ottawa four months earlier, at which a full report had been read. It appears that the most immediate duty of this committee is to study the movements of a pier during the course of a night, and if possible to devise some method by which a pier can be kept stationary within small amounts. For this purpose a 10-inch photographic telescope of 100 inches focal length has been constructed, and is now being mounted upon a pier at the Allegheny Observatory. The pier and telescope are to be kept at a nearly constant temperature in a basement room at the observatory. At frequent intervals throughout the night, short exposures are to be made upon the region of the pole, access to this part of the sky being obtained through a window of plane parallel glass. Dr. Schlesinger also referred briefly to the progress made by Dr. Ross with the photographic zenith-tube designed by the latter and mounted by him at the International Latitude Station at Gaithersburg. The material thus far secured indicates a considerable reduction in accidental errors, as compared with the best work of the zenith telescope by Talcott's method. This instrument had been in operation during a few months only, and consequently no information is as yet forthcoming as to the freedom of the method from systematic error.

A verbal report by Professor C. L. Doolittle, chairman of the committee on cooperation in the teaching of astronomy, was followed by an extended and profitable discussion.

Late in the afternoon of Friday, December 29, the society adjourned to reassemble at the Allegheny Observatory, Pittsburgh, in the following August.

R. H. Curtiss,
Editor for the Meeting

Ann Arbor,
February, 1912

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

The meeting of the Academy of Science of St. Louis was held at the Academy building on Monday, March 18, 1912, at 8 P.M., President Engler in the chair.

Professor C. A. Waldo, of Washington University, addressed the academy on "The Problems of Coal Exhaustion."

"Miniature Flint Arrows" was the subject of a short paper by Dr. H. M. Whelpley, who illustrated his remarks with over 2,000 specimens, varying in length from .06 to 1 inch. In form they represent all of the common types of ordinary arrows and were evidently made by the same process of pressure chipping. Specimens have been found in England, Spain, Belgium, India, Palestine, Egypt and the United States. These artifacts belong to the Neolithic age. It has been suggested, but without evidence, that they were made by a pygmy race of human beings. It is also claimed that they were barbs for harpoons, tattooing instruments, fish snags or drills for skin and shell work. Dr. Whelpley concludes that the medium size and larger miniature arrows, such as are very plentiful along portions of the Missouri and Meramec Rivers, were used as arrow heads. The most minute ones he considers examples of skill in flint chipping, the same as the miniature baskets made by the Pomo Indians to-day are merely examples of skill in basketry.

Dr. R. J. Terry reported on "A Grove of Deformed Trees."

A grove of four or five hundred small persimmon trees in St. Louis County has suffered from the ravages of a beetle which has been identified as *Oncideres cingulata.* Limbs varying in diameter from 5 to 15 mm. are girdled and the ends fall to the ground. All the trees, old and young, have been attacked. The girdling is done in the fall, mainly in September and October. During this time the larger trees present scores of branches bearing dead leaves and the ground is strewn with fallen branches often laden with fruit. There is no tree in the grove that does not present crooked trunk and limbs. The deformities in some cases are extreme. Most of the trees are as a consequence dwarfed, although able to make some advance in growth. Some trees only a meter and half tall bore fruit in 1911.

A few beetles have been observed working. The cut was begun on the upper side of the branch and was made 3–4 mm. wide and about 3 mm. deep. Most of the limbs fall, probably within a few days after the girdling. A small proportion remain throughout the following winter. On every severed branch, near the distal ends of the twigs, one or more small deep excoriations of the bark were found. That the beetle makes similar abrasions of the bark of twigs of the honey locust is known from observation on *Oncideres* in captivity. Limbs recovered from the ground in winter in some cases presented no evidence of the propagation of the beetle, whereas in others more or less of the wood had been destroyed under the bark along one side of the branch extending from the distal end proximally. The cavity never quite reached the proximal severed end. Larvæ which are now being studied were discovered in some of the tunnels.

AT the meeting of the Academy of Science of St. Louis, held at the Academy building, March 4, 1912, Dr. Charles A. Todd addressed the academy on "A Problematical Geological Phenomenon in Colorado."

In the Estes Park district of Colorado there is a remarkable collection or aggregation of rocks, the exact nature of which at present is undetermined. This geological puzzle is in the form of an oblong pit with sides sloping at an angle of 45° and meeting at the bottom. Its length is 600 feet; width, 200; depth, 50. These measurements are only estimates. At the eastern extremity of this oblong is a circular pit 150 feet in diameter. Both pits have the same general characteristics. Their walls are of more or less cubical masses of country granite, sharp angled and solidly jammed together for the most part. The largest blocks are on the upper part of the wall; one I judged to be 30×40 feet with irregular thickness. These pits are in the valley of Fern Lake on a branch of the Thompson River and about three miles from the Continental Divide. They are on the right-hand side of Fern Lake, forming part of the shore. All this district has been subject to glacial action and this valley gives all indication of having been plowed out by the ice. Fern Lake is a circular glacial lakelet about one fourth of a mile in diameter and said to be 75 feet deep. Its shores drop off abruptly with the depths. Just above the lake is a bench extending two miles up stream to another and larger glacial lake. At the lower end of Fern Lake is a terminal moraine, filling the valley (which is here about three fourths of a mile wide) and extending down stream two miles, where the main Thompson flows through a rather wide cañon. The question is, how came these rocks here and so arranged. Two theories are advanced: One is that the pits represent a "blow-out." In that case the applied force must have been gaseous, since there is no lava or ash in the neighborhood. The second theory is that the rocks are glacial deposit. They are, as stated, in the course of the ice stream and next an extensive moraine. But the peculiar configuration of the pits, the sharp angles of the cubical fragments, etc., seem to oppose this view. The surest way to settle the matter evidently would be to sink a shaft in the bottom of the main pit and determine whether or not the broken rock extends well below the general level of the valley at that point.

Dr. H. T. A. Hus, of the University of Michigan, read a paper on "Inheritance in *Capsella.*"

Professor Nipher made a verbal communication concerning some of his more recent work on the nature of the electric discharge. Former results of his work seem to point very strongly to the one-fluid theory. It would follow that the two waves which were shown to exist in the Wheatstone experiment were compression and rarefaction waves. The negative wave is in the nature of a supercharge which travels along on the outer surface of a thin outer film of the conductor. The positive wave is one in which a thin outer film of the wave is suddenly drained of the negative charge, at the instant of passing of the wave. We had been led to suspect as a result of recent experiments that

matter in this latter condition is explosive. The tests have been made on thin fuse wires sealed into long glass tubes through which the wire passes. The wires were sealed in by means of hard sealing wax. A discharge from a battery of Leyden jars was passed through the wires. The disintegration of the wires is much greatest at the positive end. The sealing wax, wire and glass tube in almost every case, break down at that end. The lead is dispersed in a fine powder or dust.

Professor Nipher remarked that he had just found in the London *Phil. Mag.*, Vol. 46, of 1815, pp. 161 and 259, an account of the work of De Nelis and Singer, who passed a positive discharge through a lead wire of 0.01 inch diameter contained in an iron tube. The wall of the tube was usually about 0.14 inch in thickness. In one case the tube was one inch in external diameter, with a small bore admitting a steel needle with wax insulation and terminating in the short lead wire resting on the bottom. The lead wire was surrounded by oil. Such tubes were burst by repeated explosions of the lead wire, which required to be replaced at each discharge. The discharge was from a battery of Leyden jars having an area of from 75 to 100 square feet. The needle and part of the liquid were thrown out at each explosion. In some cases the liquid was thrown to a height of 40 feet. The experimenters do not seem to have used the negative discharge. They attributed the effects to the expansive power of the electric fluid.

What they were doing was to suddenly drain that lead wire of the negative fluid. The atoms of lead then repel each other. Some of the effect is of course a heat effect. The question arises, however, will the negative discharge produce a like or an equal effect? Is it not possible that such molecular repulsion is primarily concerned in the formation of disruptive channels in air and resulting in spark discharges and lightning?

George T. Moore,
Corresponding Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The 79th regular meeting of the society was held at the Shoreham Hotel, Tuesday, March 5, 1912, at 8 o'clock P.M. President W. A. Orton presided. This being the annual open meeting the program was devoted to an address on "The Present Status of the Genetics Problem," by the retiring president, Professor W. J. Spillman. The address will appear in Science.

The 80th regular meeting was held at the Cosmos Club, Tuesday, April 2, 1912, at 8 o'clock P.M. President W. A. Orton presided. Eighteen members were present. Dr. Errett Wallace and Messrs. L. H. Evans, S. M. McMurran and S. C. Stuntz were admitted to membership.

The following papers were read:

Studies on European Herbaria with Special Reference to Preservation of Type Specimens: Walter T. Swingle.

The speaker on recent visits to the principal European herbaria was impressed by their lack of the geographic limitations, so common in American herbaria. However, the management is much the same as it was a century ago. There is no adequate correlation of the seed and fruit collections with the plants in the herbaria. Alcoholic specimens scarcely exist, and such as are found are neither well indexed nor referred to on the specimen sheets.

The method generally followed at present of leaving types along with the other specimens is certain to lead to their rapid deterioration and ultimate loss. Provision should be made for saving fragments which may drop from the specimen and to this end it was suggested that a sheet of transparent paper be pasted to the back of the herbarium sheet, bending over it, thereby protecting the specimen. Smaller types and fragments of types can be preserved in pasteboard boxes with a glass top, the specimens being pressed against the glass by layers of cotton batting.

It is important to recognize that in plants type specimens can often be indefinitely multiplied by cutting branches from the same plant, or by securing flowers or fruits from the same plant during successive years. These types which are secured from the same plant individual are termed merotypes.

The Celebration of the One Hundredth Anniversary of the Academy of Natural Sciences of Philadelphia: W. E. Safford.

Mr. Safford, the delegate of the Botanical Society at the academy's centenary celebration, gave a graphic and comprehensive report of the meetings and made special mention of the papers of botanical interest there presented. The speaker also gave an account of the development and resources of the academy's herbarium.

W. W. Stockberger,
Corresponding Secretary